Clarence Weeks
Calgary Normal
1st Year

Teacher's Manual

—IN—

NATURE STUDY

—FOR—

Alberta Public Schools

BY

JOSEPH M. SCOTT, M. Sc ,

Instructor in Nature Study
Calgary Normal School

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INTRODUCTION

This manual has been prepared to meet a demand of many teachers who are experiencing difficulty in presentation of the Course in Nature Study outlined in the new Programme of Studies. The author believes that the teachers have not the time at their disposal to consult several reference books on the topics suggested in the outline, or can the financial outlay involved for the purchase of many books of reference be justified at the present time. The general plan adopted in the preparation of the book has been to follow the order of treatment indicated in the Programme of Studies. To avoid needless repetition of subject matter, a rather extensive study of certain features is made in one chapter and not discussed in the other sections of the book. Thus the identification and life histories of common moths and butterflies are studied in Chapter II, the identification of common birds, the study of trees and common mammals are found largely in Chapter III, etc.

The author wishes to make acknowledgment to the following writers whose works have been freely consulted in preparation of the manual: Mrs. A. B. Comstock, H. H. Cummings, Margaret W. Morley, Clarence M. Weed, L. H. Bailey, Frank M. Chapman, C. F. Hodge, S. Silcox, O. J. Stevenson, P. A. Taverner, G. F. Atkinson, J. H. Comstock, Mabel O. Wright, B. P. Colton, Ernest Thompson Seton, W. C. O'Kane, Neltje Blanchan, John Burroughs, F. W. Stack, Julia W. Henshaw, F. O. Payne, David S. Jordan, V. L. Kellogg, T. H. Burlend, G. A. Cornish, W. C. McCalla, B. R. Morton, F. Overton, W. H. Atwood, J. M. Coulter; also to the publications of the Dominion Department of Agriculture, Provincial Department of Agriculture, Ontario Department of Education and National Association of Audubon Societies.

CHAPTER I.

GRADES I AND II

Many of the topics in Nature Study suggested in the Course of Study for study in these grades are treated in later chapters of this book. The identification and habits of our common birds are discussed in Chapters II and III, the study of many common fall and spring flowers is taken up in Chapters II and V, trees are studied in Chapter III, seed germination is treated in Chapter II, many common mammals are dealt with in Chapters II, III and V, while identification and life histories of insects are a prominent feature in Chapter II. If the teacher finds that a topic is not discussed in this chapter she should glance through the subject matter of the other chapters where she will probably find a treatment of the topic in question.

AUTUMN PLANT STUDY

A field trip in September for these two grades will not only enable the pupils to see the fall flowers in all their glory but also give them an opportunity of gathering materials which will later be made the subject of study in the classroom. It should be borne clearly in mind by the teacher that a field trip is not designed simply to provide recreation for the children. In order that a field trip may prove a success from the standpoint of Nature Study two things are demanded of the teacher: (1) The teacher should have been "over the ground" herself previous to the trip to see what materials are available for observation. Rarely does one find a teacher who can take a class out into the field without any planning or preparation and have the pupils gain sufficient thereby to justify the time taken from the regular routine of the classroom; (2) The trip should be taken with **one** definite purpose in view, which should be announced to the class before starting. Any other matters which crop up in the trip should receive little attention. For the primary grades two short field trips in autumn will prove of more value to the pupils than one excursion which occupies considerable time. The first trip should be taken early in September in order to have the children become acquainted with a few of the common plants and collect the leaves for later study. The second trip at the end of the month will afford them an opportunity of seeing how seeds of plants are scattered and collecting specimens of the seeds with their cases and attachments.

It will be wise for the teacher to dry and mount leaves of common plants as suggested in Chapter V. Instead of writing the names under the leaves, use large numbers written in India ink if possible. A better plan is to have only one leaf on each small sheet with a number below it large enough to be seen from any part of the room. As an introduction to the lesson on leaves the teacher may ask the pupils to name all the things upon which they have seen leaves growing. The replies will probably be on flowers, trees, vegetables, plants, etc. They may then be asked to examine the leaves which they have collected on their trip and find out whether all the leaves are the same shape. If they have leaves of a willow they may first learn the name willow and then have the term **lance** shape applied to this leaf. The leaf of a nasturtium may be taken as a **shield** shape, that of most grasses as **ribbon** shape, that of the violet as **heart** shape, etc. The leaves of six plants at the most should suffice for a lesson. As a drill the teacher may hold up a pressed specimen of one leaf, and ask one pupil to name its shape, and a second pupil to give the name of the plant. This practice may then be followed with other leaves. Another method of drill would be to have the sheet of mounted leaves where all could see it, and require a pupil to come up and point out a thistle leaf, a heart-shaped leaf, etc. If a child makes a mistake in identification, the error should be noted and corrected by the other pupils rather than by the teacher.

DISPERSAL OF SEEDS

The dispersal of seeds always proves an interesting topic for these grades. If the blue bur (stickseed) is found in the school district it may be selected as an example of seeds that steal rides by sticking to people's clothing and the hair of animals. The pupils should break up one of the burs into the four seeds and notice the little hooks which enable the seeds to cling to cloth and hair. Other examples of seeds fitted with barbs are northern bedstraw, avens, agrimony, and to some extent the buttercup. The latter plant has the seeds contained in a globular head, each seed having a curved hook at the upper end. The wild barley ("foxtail") has awns on the seed which stick to one's clothing. The sage brush, or it is often called the wild sage, which is everywhere abundant on the prairie, has seeds covered with a fine mucilage or gum, which causes the seeds to stick to animals for a time particularly after a rainstorm.

The thistle and dandelion are good examples of seeds that have balloons attached to them that help them to sail away through the air when there is the slightest breeze. If the children examine one of the seeds they will find that the outer surface has a number of projecting points which anchor the seed to the ground wherever it lights. If the great willow herb (fireweed) is found in the district the pupils should watch the long narrow four-sided pods in early September. The pods when mature split from above downward, each of the four divisions curling back. Then the tiny white hairs attached to the seed expand to form parachutes to carry the seed through the air. The golden rod and aster are other examples of seeds having balloons, although they are not as conspicuous as those of the dandelion and thistle. The willow, poplar (cottonwood), and cattail are other common seeds which have downy attachments that aid them in dispersal by wind.

The Manitoba maple, a tree extensively used for shade purposes in Alberta, has a seed pod with a thin light wing which enables the wind to carry it some distance. If a spruce tree is found near the school, obtain one of the cones which still retains its seeds. Stand on a chair before the class and shake a few of the seeds in the air for a time. The cone may be considered as the cradle in which the seed babies are rocked. The Russian thistle and tumbling mustard may be selected as examples of seeds that are often given long free rides because the plant breaks off at the ground when mature, and its spherical shape makes it easy for the wind to send it tumbling over the prairie. The children should split open one of the long pods of the mature tumbling mustard (often mistaken for a stem) and notice the great number of small seeds which it contains. If the seed case of a garden poppy is available the pupils may see the small openings near the top. When the erect stem is swayed by the wind, the seeds are shaken out, a few at a time.

If the ripe pods of sweet pea, carragana, vetch, or wild geranium (crane's bill) are examined when still on the plant the children will be able to see the twisting of the pods which often scatters the seeds for a distance of several feet. The common blue violet shows the same adaptation. The rose hip may be broken open to examine the seeds within. The pupils may often see the birds eating the bright colored hips in autumn. If they watch the birds closely they will see that they sometimes carry the hip in their beak for a distance, and then eat the fleshy outside part of the hip, but as a rule reject the hard seeds.

The teacher may prepare a very attractive seed collection without any great expense or labor. Obtain a pane of window glass and two pieces of stiff white cardboard of the same dimensions as the glass. In one of the sheets cut holes one inch in diameter and one-half inch apart. Place a thin layer of cotton (druggists sell surgical absorbent cotton in strips of different widths) between the cardboards. In one row of pockets place seeds that are carried by the

wind; in a second, seeds carried by animals and men, and in a third the ones scattered by mechanical means. Print the names of the seeds in India ink on the cardboard below the pockets. Place the pane of glass over the pockets to hold the seeds in place. Use either passe-partout binding or a picture frame to hold the cardboard and glass together.

The sunflower, golden rod, thistle, aster, tumbling mustard, painted cup and fireweed are studied in later chapters so that it is unnecessary to give any details of these plants at this point. Lessons on garden flowers such as the pansy, sweet pea and nasturtium are also suitable for this grade. Each child should have a specimen of both flower and leaf, and the teacher should have a plant with the attached soil in a can or box. In the case of the pansy have the pupils note the resemblance of the flower to the face of a human being. Where are the eyes? The two dark spots at the base of the side petals. The opening to the nectar spur may represent the nose, and the spot near the base of the lower petal may be called the mouth. Their attention should be drawn to the guiding lines on the lower and side petals which point to the opening which leads to the nectar spur. The insects are thus guided to the nectar. If they see a butterfly or bee on a pansy they will notice that the insect uses the broad lower petal as a resting point while it is inserting its long tongue into the nectar tube.

The relationship between the flower, stem and root of the plant should also be developed by questioning. What happens to the flower after it is broken off the plant? Are any of the flowers on your desks withering? If you want to prevent the cut pansy flowers from withering for a few days what do you do? From this can you tell what the flower must get from the stem? Where does the stem of the growing pansy plant get the water? Can you now tell one use of the root of the plant? The teacher may then show the difficulty of pulling the plant out of the soil and have the pupils infer the second use of the root. Then carefully remove the plant from the soil. The pupils can see the twisting form of the roots for grasping the soil firmly and the number of little rootlets touching a great deal of soil so that they can gather much food and water for the plant. The leaves may then be examined and the different shapes noticed. As an exercise, individual pupils may be required to come to the front of the class and pick out a pansy leaf from a pile of leaves of various plants collected by the teacher. The leaf should then be held up before the class for vertification. If a child makes an error in selection he may be asked to compare the leaf he selected with the pansy leaf on his desk.

LEARNING THE DIRECTIONS

Many primary teachers have followed the practice of having the pupils regard the point where the sun rises as east, and where it sets as west. At certain seasons of the year this procedure is open to serious criticism. We should remember that there are only two days in the year on which the sun rises in the east and sets in the west, namely, at the time of the equinoxes (September 21st, March 21st). After September 21st the sun rises farther and farther south of east until it reaches its maximum distance south on December 21st. From March 21st to September 21st the sun rises north of east.

The most satisfactory method of teaching the directions by the sun is to use the fact that the sun is on our meridian at noon. If the sun is shining at noon the children may go out in the yard and notice the direction of the shadow of a fence post or for that matter their own shadow. It will point due **north** at noon on **every** day in the year. This method is open to the reservation that it must be carried out at noon by sun time, not by our watches, which show standard or (man's time). Without going into the details of the difference between the two, which is really a topic in the Geography of Grade VIII, it may be simply indicated to the teacher that in places in the

longtitude of Medicine Hat it is noon by sun time at 12:25 by our watches while in the longitude of Calgary it is not noon by sun time until the hands of the watch read 12:35. On the main line of the Canadian National Railway, points west of Edson use standard time which is one hour slower than that used in the east of the province. Just west of Edson it is noon by sun time when the time by the watches is only about 11:45.

When the children face the direction in which their shadows lie at noon the term north may be introduced. Their backs are to the south. If they hold their hands in line with their body their right hands will point to the east and their left hands to the west. While they are still standing in position on the school grounds have them determine the direction of their homes and other important points. In the class room the teacher may gradually fix the directions in the minds of the pupils by from time to time during the next few weeks having a child open the east door or bring an eraser from the north blackboard, or lower a blind on the west window, etc. The writer rather doubts the advisability of referring to the compass in these grades, since the instrument rarely points to the geographical north.

WEATHER CALENDARS.

In Grade I the pupils will be ready to start work on weather calendars in April. The teacher, if time permits, may have a calendar for that month outlined on the blackboard. The pupils may either bring a sheet from a calendar at home or some of the pupils in Grades II or III may rule off a page and place the numbers on it for the younger pupils. For Grade I it should be sufficient to indicate whether the predominating feature of the day was sunshine, clouds, rain or snow. The weather conditions at the same time each day may be reported on the calendar. For sunshine a yellow circle with a few rays drawn with crayola would be an easy method of representation. Snow might be represented by filling the square with a black lead pencil and then making a few dots with white chalk. Rain might be shown by a rough sketch of an umbrella or by simply using short slanting black lines. Clouds might be indicated by a yellow circle with black lines drawn across it or with the entire circle filled in black. The resourceful teacher soon finds many different methods of representation of features.

If the pupils in Grade II know the four semi-cardinal directions (N.E., S.E., N.W., S.W.) towards the end of the term the teacher may have them determine the direction of the wind at a certain time each day and record it on a calendar. It is well in this case to use the the conventional method of designating directions on maps. Thus if the wind is blowing from the north an arrow may be shown pointing downwards from the upper side of the square; a southwest wind would be represented by an arrow pointing from the lower left hand corner of the square.

INSECTS IN FALL.

Several kinds of caterpillars are usually found in most districts when the school opens in September. The green worms which are found to such an extent upon the cabbage and cauliflower plants may be used for the study of the development of the caterpillar. Place the caterpillars with a fresh cabbage leaf in a sealer covered with mosquito netting. Have the pupils notice that the caterpillars are eating holes in the leaves. Provide a fresh leaf daily. The caterpillar when full grown is from 1 to 1½ inches long. If a small piece of wood has been placed in the sealer, the caterpillar will spin a silk button to hold up the hind part of the body and also a girth of silk about the middle of the body. It then sheds its skin, displaying the chrysalis, which often takes on the color of the object on which it hangs. The pupa remains in the chrysalis stage for about two weeks, and then the white butterfly emerges. In some

instances if the caterpillar is not full grown until late in the fall, it may pass the winter in the chrysalis stage. The pupils should notice that the wings of the butterfly when it first emerges from the crysalis skin are small and damp, but that they soon spread out and dry.

The pupils often find red and black or yellow hairy caterpillars crawling along the ground very rapidly in September. The children have given them the popular name of "the woolly bears." These caterpillars are the larvae of tiger moths. If they are brought into the school for observation it will be found that they soon curl up and go to sleep for the winter. In the spring they will spin a rough hairy cocoon, made to a considerable extent from the cast off hairs of the caterpillar, and fastened in place by silken threads. The caterpillar changes into a brown pupa inside of the cocoon and comes out as a medium sized moth about two weeks later. If the caterpillar was reddish brown in the centre and black at each end the moth will be the Isabella tiger moth—yellowish brown in color with spots on the wings. Some of the other "woolly bears" change into the virgin tiger moth, which has many pink and light yellow markings on the wings. If several of the "woolly bears" are obtained the live specimens may be placed under a number of inverted tumblers or ink bottles for observation. The children should notice that the caterpillar extends the front part of the body and moves it to and fro in order to study its surroundings. It appears necessary to do this because of the very small eyes. The children should also observe the two kinds of legs on the caterpillar. On each of the three segments of the body behind the head is a pair of shining legs with little claws on the end. These are the true legs. On the segments further back on the body and at the rear of the body are pro-legs which are simply projections that assist the insect to move in the caterpillar stage, but are not seen in later stages of the development of the insect.

Often in early September the children see on the alder, willow or poplar trees a hairy caterpillar about 1½ inches long, which has a yellow body striped with black. There are long, black hairy projections on each side of the head and one on the end of the body. There are also tufts of light colored hair on the back. This is the caterpillar of one of the Tussock moths, insects which in this stage destroy the leaves of trees. If these are brought into the classroom they will soon spin white or ash colored cocoons, and about ten days to two weeks later the moths will emerge. The female of the Tussock moth is rather remarkable from the fact that it does not possess wings. If the children do not find the caterpillars they may sometimes see the open cocoons on a tree with eggs on its outer case. These eggs will hatch into caterpillars in the spring.

It is wise for the teachers to encourage the children to bring to the classroom any caterpillars which they can find. They should also be instructed to bring some of the plant upon which the caterpillar was found. The caterpillar and plant may be placed in a sealer which has two or three inches of moist soil in the bottom. The soil is necessary because there are certain caterpillars such as those of the sphinx and cutworm moths which do not spin a cocoon, but make their way into the soil, where they change into brown pupae. It is unnecessary for the teacher to know the name of the caterpillar. The chief object in Nature Study is not the mere naming of natural objects, but rather the study of their habits.

PLANT STUDY IN WINTER.

The slipping of a geranium and the growing of a new plant from it are suggested in the course of studies as a project for this season. In order to determine whether a plant has stems suitable for making cuttings give one of the stems a quick bend. If it snaps and hangs by the bark it is at the proper stage. Plants which

are either too soft and young or too old will bend without breaking. Some old woody plants will form splinters. Make the cutting straight across the stem with a sharp knife. Choose preferably the growing tip of the stem and make the cutting about 4 inches long. Cut the stem just below a joint, as it is at this point that roots will form most easily. Remove all the leaves with the exception of one or two small ones at the tip of the stem, in order that moisture may not be given off rapidly while the cutting is taking root. A small box about 4 or 5 inches deep is very satisfactory for the first planting of the cutting. Have a few small holes in the bottom of the box to provide drainage. Put a layer of fine gravel about an inch deep in the box to enable ready passage of air and water. Then fill the box with moist clean sand. Do not use garden soil, as it is likely to contain fungi which will cause the plant to "damp" off and die near the soil. Plant the cutting in the sand so that about 2 inches of the cutting are below the surface of the soil. Pin a newspaper around the box to the height of the cutting so that it will be protected from the strong light. Keep the cutting in a warm, bright room for three or four weeks to give the root an opportunity to develop. As soon as the plant starts to develop new leaves at the tip we may feel sure that the roots have formed. During this time the soil should be kept moist, but do not soak it with water.

The plant is now ready to be transplanted. A small flower pot or a can which has had several holes punched in the bottom is suitable for the purpose. As before, a few stones should be placed in the bottom. Over this place a layer of rich humus soil such as found where leaves or logs have decayed. Transfer the cutting to the pot, being careful not to break off the small rootlets. After setting the plant in place pack soil firmly around the roots and fill the pot to within about half an inch of the top. Geranium cuttings made in January or February will bloom during the following winter. Ordinarily geraniums should not be kept more than two years, as after that time they have not the vigor or the abundance of blooms found on the young plants.

The germination and growth of the bean are studied in the next chapter. The pumpkin, pea, and sunflower seeds may also be planted at the same time as the bean, and the differences in growth noticed. In the case of the pea it is the stem **above** the attachment of the two halves (cotyledons) of the seed which grows. The pea is thus left in the ground, instead of being lifted out of the soil as is the case with the bean, which has a stem that elongates from **below** the cotyledons, not above them. The pumpkin seed develops an interesting device to help it to shed its seed coat. The root as it emerges from the small end of the seed is only able to split the shell (seed coat) to a slight extent. On the under side of the stem, as the seed is lying on its side, a small "peg" is formed at the opening of the seed. This peg helps to split the coat further open by pressing against the end. When the stem starts to grow above this peg, it presses against the other half of the coat, and the halves are opened to such an extent that the plant slips out of the seed coat.

Frank O. Payne, a pioneer in Nature Study in the United States, has outlined a method of studying the germination of the bean which has been carried out in the first grade in his school. The children first observe the location of the scar on the seed, and are told that this is where the seed grew to the pod. They are then told that inside the seed is a little baby plant, and that there is a little gate or door where it can come out when it is big enough. This little opening (micropyle) or gate is pointed out to them on the seeds which they have on their desks. The little baby plant must have a coat to keep it warm. Several soaked seeds are distributed and the pupils remove the overcoat (outer seed coat) with a pin. They are asked to describe this overcoat, and such words as white,

smooth, and tough come up. They are then told that Mother Nature gave the little baby plant two coats, and are asked to find the **under** coat (inner seed coat). They remove this carefully in order not to waken the sleeping baby. They next are directed to separate the two seed leaves and see the little baby lying in between. The pointed portion (radicle) is pointed out and called the baby's foot; then the two little leaves (plumule) are called the baby's head. The children later watch the little baby creep through the gate on some fresh seeds which were planted on wet cotton or sawdust in tumblers. They placed dry and soaked seeds on their paper, and traced their shapes. Later they made some simple drawings of the plants as they developed.

In dealing with bulbs, the teacher will find the Chinese lily most satisfactory for Grade I, as it may be grown in water (see next chapter) and will bloom in about six weeks from the time when it is planted.

WINTER BIRDS.

Under this head we should study two groups of birds: (1) The birds which are here throughout the year, but are most conspicuous in cold weather because of the scarcity of feathered folk during that season. (2) Birds which are usually only found in the district during the winter months.

There is probably no winter bird as beloved by little children as the merry chickadee. The pupils should be encouraged to hang out pieces of suet on any trees or tall posts near the school in order to attract this little feathered friend to the vicinity of the school. The pupils will soon learn to recognize the chickadee by his black cap and bib, as well as general greyish and white coloration of the rest of the body. They should also identify and imitate the characteristic note, chick-a-dee-dee-dee-dee. Some knowledge of the good work that the chickadee is performing for us during the winter may also be acquired by the pupils by having them watch the bird obtaining insect eggs and the insects themselves on the branches and underneath the bark. They can see how well his little pointed beak is adapted for procuring his food. His thorough inspection of every part of the branch with his sharp eyes and his ability to stand 'any side up" should also be noted. The pupils will also find that the coldest weather does not prevent the chickadee from making his rounds in search of food. Only during a blizzard does he find it necessary to seek a refuge in a hole in a tree or some other sheltered spot. The children will probably believe that the chickadee leaves us in the spring, as it then is found most commonly in the woods, where it builds its nest in holes in decaying trees.

The English sparrow, commonly called the house sparrow or simply the sparrow, does not command our admiration and appreciation as does the chickadee. The children should compare the quarrelsome habits of this bird with the friendliness of the chickadee. Its harsh chirp may be brought out in contrast with the cheery note of the chickadee. The larger size and brownish color of the sparrows may also be noted. The black bib of the male bird, and the "washed out" appearance of the female bird should also be drawn to the children's attention. The English sparrow differs from the chickadee in its food habits, as it lives largely on weed seeds and grain during the winter. It also devours any crumbs which are thrown out. The strength and thickness of the beak as compared with that of the chickadee may be dealt with. The children should be encouraged to destroy the untidy nests which the birds construct early in the spring, as the sparrows drive away the birds which are useful to man.

There are two birds to which the name snow bird is popularly given by the children. The junco (black snow bird) is easily distinguished from the other small birds seen during the winter

by the fact that it is slate grey above and on the breast, with white below, and has a light colored beak. The contrast between the two colors is quite sharp. In flight the white outer tail feathers serve to identify it. The snow bunting (snowflake) is the other form of snow bird. During the winter the under parts of the bird are white and much white is also found scattered among the rusty red of the head, neck, wings, and tail. Both birds are seed eaters like the sparrows. The snow buntings nest in the Arctic regions, while the juncoes often build their nests near their winter feeding grounds.

The redpoll, pine and evening grosbeaks, ptarmigan, horned larks and snowy owl which are winter visitors in some parts of the province are discussed in Chapter II. If the prairie chicken or ruffed grouse or Hungarian partridge (see Chapter II) are seen near the school during the winter, the teacher may make them the subject of an interesting lesson.

SPRING PLANT STUDY.

The twigs of willows and poplars may be placed in water in March and the development of the buds watched by the pupils. The development of the willow buds is dealt with in Chapter II. In the case of the willow and poplar the buds which contain flowers are rather wide and plump, and develop before the slender sharp-pointed buds which contain the leaves. If the saskatoon twig is studied it will be found that the buds are "mixed" buds; that is, they contain both leaves and flowers.

The pasque flower (purple anemone, crocus), buttercup, violet, buffalo bean, and many other flowers of spring are studied in succeeding chapters. The purple anemone is the first flower of spring, and deserves the attention of the pupils in all parts of the prairie. A short outline of the study of the dandelion for the primary grades is given at this point.

DANDELION.

The pupils will be interested in knowing how the plant obtained its name. They should notice the way in which the margins of the leaves are notched. A Frenchman thought these teeth resembled those of a lion, and gave the name "dents de lion" to the plant. The English have made the word dandelion from the French name. The arrangement of the leaves in a rosette just above the ground may be compared to a number of rain spouts which guide the rain to the root of the plant. They should examine the flower heads in the evening and in wet weather. They will see that the flowers are asleep, for the green bracts below the head close around the flower. They should also notice that where the grass is short the flower stem does not grow to any great height, but where the dandelion is growing in tall grass the stem grows tall so that the flower may get plenty of sunlight. They may watch the bees, ants and other insects which visit the flower to obtain honey (honey instead of the term nectar may be used in these grades). The pupils will also be interested in making chains and curls from the long stems. Later they will find that many of the flower heads do not open even when the sun is shining brightly. Some of these heads should be split lengthwise so that the pupils can see the seeds and fluff forming. When the dandelions are ready to scatter their seed the stem grows longer and the large white ball gradually emerges, so that the wind may carry away the fluffy balloons with the attached ripe seeds.

AN AQUARIUM AND ITS OCCUPANTS.

A few quart sealers may be made the centre of the interest of the pupils in the spring months if the teacher converts them into aquariums. If frog's eggs are found they may be developed in one sealer as outlined in Chapter II.

Two or three inches of clean sand should be placed in the bottom of the aquarium. Some water plants should also be placed in

the sealer with their stems in the sand, and the jar filled with water. The jar should be kept in the sunlight for a few hours each day in order to set free oxygen for use of the occupants. The common water snail is always the source of much interest to the children. It always carries its house (shell) around with it, and withdraws within the shell at the approach of danger. The pupils should notice that it comes to the surface from time to time to breathe. If you find a snail which does not come to the surface to any extent it is a river snail, which has gills instead of the lungs of the pond snail, and hence is able to obtain the oxygen that is dissolved in the water. The children should notice the long, flat foot of the snail. Also the pair of feelers on the front of the body, at the base of which the eyes of the animal are situated. The snails are very valuable for the aquarium, as they may be seen eating the layer of green scum which grows on the sides of the vessel. The young snails have shells with only one spiral. Later layers are added to the shell on the rim about the opening. The eggs of the water snails, like those of frogs, are laid in jelly-like masses which are usually attached to water plants.

The caddis-fly larvae are also a very interesting form of water animal life. If the leaves and grass at the bottom of a small stream or slough are raked up in May or June one often finds what appear to be simply twigs or cylinders of stones. Close observation will show that a small worm is the occupant of this structure. There is a frame work of tough silk, to which the wood, stones, etc., are attached. The children will notice that the dwelling has both a front and a back entrance. The dark head and front segments of the body bearing the legs are often seen protruding out of the front door. In some cases we may often see the abdomen with some short white threads on the sides. These threads are the gills, which enable the insect to obtain air from the water. The passage of the water through the two entrances of the dwelling gives a constant supply of air for the worm. The children may notice that the house protects the caddis worm from fish, both by its inconspicuous appearance and also by providing a rather uninviting material to swallow. The worm holds itself to the silken lining of its home by hooks attached to the hind end of the body. During the pupa stage the two entrances to the case are partially closed with silk to keep out intruders, but not interfere with the passage of water through the case. The adult caddis flies are often mistaken for moths. They have four brown or grey membranous wings covered with hairs, and are often found flying around lights in the evening.

The wrigglers of mosquitoes which are found in stagnant water, sloughs, rain water, etc., are also well worth while studying if the children can obtain them. They will notice that many of the wrigglers are quite lively and come to the surface from time to time to obtain air through a breathing tube. These are the larvae. Others seem to be all head and spend much time at the surface of the water practically motionless. The latter are pupae and will usually change into an adult mosquito in the course of a few days. When the pupa is ready to make the change it comes to the surface, the pupa case splits open, and the adult mosquito uses the case as a raft until its wings are dry and it can fly away. The eggs are laid in large masses which form a raft that floats on the surface of the water. Some of the wrigglers should be placed in a tumbler of water and a little kerosene (coal oil) poured on the surface. The pupils will find that the wrigglers die later because they cannot push the breathing tubes through the oil to obtain air. This method has been used on a large scale to destroy the mosquitoes which carry the germs of malaria and yellow fever in tropical countries, for example in the Panama Canal Zone.

CHAPTER II.

GRADE III.

STUDY OF PLANTS of LATE SUMMER AND AUTUMN

COMMON THISTLE

The large flower heads of this plant often incorrectly called the Scotch thistle, are conspicuous features of the landscape in late summer and autumn. It is difficult for the average child to distinguish the plant from the wavy leaf thistle, which also has a large purple flower head. No attempt should be made to do so in this grade. The most striking feature about the plant is the sharp spines which protect the plant from being eaten by grazing animals. The dense, matted wool-like hairs found on the bristling stems prevent climbing ants from stealing nectar from the flowers. Dead ants are often found on the plant pierced to death by the protective armor of the plant. The children should note that the scales on the outside of the flower head are also protected in the same manner. They will no doubt be interested in knowing how the thistle was chosen as the national emblem of Scotland. (The Scotch thistle resembles our common thistle to some extent). During one of the invasions of Scotland by the Danes the latter attempted to creep up upon the Scottish camp at night by marching barefoot. One of the party accidentally stepped upon a thistle and uttered a sharp cry which aroused one of the Scottish sentinels. The latter immediately gave the alarm to his sleeping comrades who utterly routed the invaders.

The children will find small thistle plants with a rosette of leaves similar to a dandelion but bearing no flowers. These are the plants of the first year's growth, which store up food in the roots and underground stems. (Dig up one of the plants so that the children may see the thick roots). This food enables the plant to start its growth early in the spring and produce flowers and seeds during the second year. The plant dies off at the end of the second year. The purple flowers are visited by the bees and butterflies in search of the nectar stored up in the deep tubes of each little flower. The insects pay for their sweets by carrying pollen from one flower to another. The goldfinch (see Chapter III) is also a frequent visitor to the flower. Not only is it fond of the seeds, but it uses the thistle down attached to the seeds for lining its nest. Have the pupils take one of the dry seeds with its feathery attachments and blow it from their hands. They will thus see the way in which the seed is dispersed by the wind.

GIANT HYSSOP

The giant hyssop, like the wild bergamot, is a member of the mint family. It grows to a height of from 2 to 4 feet on smooth, many-sided stems. The fragrant pointed leaves are dark green on the upper side and white below and have the margins toothed. At the top of the plant are found the long, narrow, purple flower clusters, which are from two to five inches long. The flowers appear at random on the spike, and do not open in the regular order which is characteristic of the great willow herb. In some cases, pairs of small leaves are scattered among the flowers on the spike.

SMOOTH BLUE ASTER

This autumn plant has a stout stem which grows from two to four feet high. The light green leaves have rough margins. The leaves on the upper part of the plant are usually heart-shaped and clasp the stalk, while the lower leaves gradually narrow into winged stems. The heads are about an inch in width, with 15 to 30 blue or violet ray flowers set around a yellow centre. Several flower heads are set closely together in one cluster. The seeds have white balloon-like attachments to aid in their distribution by the wind.

GREAT WILLOW HERB

The tall erect stems of the great willow herb or fire weed capped by the brilliant magenta or pink flowers are a familiar sight throughout central and northern Alberta from July until September. The name fire weed is applied to the plant because it is so commonly found springing up in a section which has been swept by forest fires. The children's attention should be drawn to the tall stems which are sometimes six feet tall, although the average height is not more than three feet. The shape of the leaves should be compared with those of the willow and thus associated with the name of the plant. When dealing with the flowers the children should observe that the lowest flowers on the spike open first and have, in some instances, gone to seed before the flowers at the top of the spike are matured. The curved violet tinted seed pods, about two to three inches long, should be noted. In September these pods are ripe and split open, enabling the pupils to procure the seeds, which are attached to white silky fluff. The pupils can readily understand how the plant spreads so rapidly if they notice the number of seeds in each pod, and the way in which the wind carries the seeds in their balloons.

PAINTED CUP—(Indian Paint Brush)

The children are familiar with this plant in any district in which it is found in the province. The plant is remarkable in one respect, that it often fastens its roots upon those of neighboring plants and thus obtains the food which its neighbors have taken in from the soil. Have the pupils carefully dig up the soil around a group of the plants and see whether there is any evidence of the painted cup "stealing" food from its neighbors. The plant differs distinctly from the great willow herb in not growing to a height of more than two feet. Often it is not more than eight or nine inches high. The stems are quite hairy. Many of the leaves show their ends tipped with scarlet or pink as if they had been dipped in paint. This plant has another striking feature in the fact that the showy colored bracts of pink, crimson, rose, scarlet, and sometimes white are practically always mistaken for the flowers. If the pupils push back the bracts they will see the inconspicuous green flowers with long pistils lying within.

WILD BERGAMOT

The bergamot belongs to the mint family, as the pupils can readily recognize by noting the odor or flavor of the crushed leaves. The heads of flowers bear some resemblance to those of the common thistle, with the dense cluster of flowers varying in color from a lilac to deep pink. The central flowers of the head open first, and the plant blooms from July to September. The corolla has two lips, the upper one standing erect while the broader lower one curves downwards. The plant varies in height from about a foot to nearly three feet. The lance-shaped leaves are arranged opposite on the stem, are greyish-green in color and are covered with fine, soft hairs, particularly on the lower side of the leaf.

The golden rod and dandelion are dealt with in other chapters. Six common trees are discussed in Chapter III. In studying the use of trees for lumber it will make it more interesting if the pupils find out the names of the trees used in making apple boxes, floors, desks, chairs, etc., and the points from which they are brought. Thus the Douglas fir, used in many houses for floors and interior finish, comes from British Columbia; the maple, for hardwood floors, from Ontario; the teacher's desk, of oak or elm, from the same province, etc.

PLANTING OF A BULB

The planting of bulbs for winter blooming should be started in the fall. A paper white narcissus bulb, which may be obtained at a nominal sum from a florist in the cities, should be planted about the middle of October to be in bloom for Christmas. The materials required for a lesson on bulb planting are a tomato can or small

flower pot, narcissus bulb, onion, sand, rich garden soil from land which was manured the previous year, small pebbles, picture of narcissus in bloom from seed catalogue.

Cut the onion across and have the children notice the scales or rings on it. These are the lower parts of the leaves from which the plant grew. The pupils should be led to see that the greater part of the bulb consists of food for the plant which will develop from it. Then note that the center of the onion is a sprout from which the leaves, stems and flowers will later develop. A picture of the plant in flower may be shown at this point, so that the pupils may have an idea of the beauty of the mature plant.

See that the tomato can has several holes punched in the bottom. (This may be done easily with a hammer and nail). Why is this done? Why is there a hole in the bottom of the flower pot? So that the excess water may drain off. Place a one-inch layer of pebbles in the bottom of the pot. This is for the same purpose as the hole—to enable air and moisture to make their way through the soil. Mix the sand and the rich soil together to within about half an inch of the top of the tin. The sand is used to permit the ready passage of the air through the soil, while the rich soil supplies some plant food. Plant the bulb with the tip just showing above the surface of the soil, and pack the soil firmly around the bulb. The small space at the top enables the plant to be watered easily. We want the bulb to become well rooted, so that it can take food from the soil before the plant grows to any extent. This will produce more and larger flowers. It is best brought about by placing the potted bulb in a cool, dark cellar for about a month. Dry leaves may be placed on the soil to prevent it from drying out. Keep the soil moist but not too wet.

After the bulb has been in the cellar for three or four weeks. if it shows green at the tip, place it in a window at the school, and it should be in bloom in a month. The children are usually interested in the development of the tall flower in the centre. At first it appears as a thick stalk, then rounds out as the petals form within. Then the stiff stem bends and the upper part of the stalk bursts open disclosing the flowers. The sheathed portion of the stalk then hangs around the stem.

The Chinese lily, which is sold by florists and is also grown by nearly every Chinaman in the province, is another interesting bulb. It may be grown in a glass dish of water, and will bloom in a month or six weeks from the time of planting. Place some charred wood at the bottom of the dish, set the bulb on them, and arrange pebbles around the bulb for support. Keep the dish about two-thirds full of water, and set in a warm, sunny window. Daffodils and hyacinths may be grown in the same way as the paper white narcissus.

SEED GERMINATION

Beans are the most satisfactory seeds to use in studying germination of seeds in this grade. Soak the beans in water for a day before planting them. Have the pupils look at the seeds several times during the day and note the changes which take place. They will notice that they become larger. The reason for their doing so should be discussed. Cut open one of the beans which has been in the water for a day, and also try to cut one of the dry seeds. The soaked seed is much softer and may be shown to have absorbed water making it larger. The pupils should also notice the change which takes place in the coat of the seed as it absorbs water. First the coat shows wrinkles at one edge, then the wrinkles gradually spread until the whole coat is covered with wrinkles. Later the wrinkles disappear. The explanation of these changes is that the seed coat takes in the water more rapidly at first than do the other parts of the seed. The evidence that it has become larger is shown by the wrinkling which takes place. Later the other parts of the bean

expand as they absorb water, thus filling out the skin again.

In order that the children may be able to follow the different stages of germination, either a box with a pane of window glass for a side or a lantern chimney or tall tumbler should be used. Roll a sheet of soft wrapping paper into a tube that will slip into the chimney or tumbler. Then fill the glass with wet sawdust or soft moss but do not pack the material. Push the beans between the paper and the glass so that they are several inches below the top. Place some seeds so that the long part is in a vertical position, and others on their side. If the tumbler is kept in a warm place, a white pointed object will come out of the hollowed side of the bean in a short time. This is the **root.** The root then starts to grow downward no matter what the position of the bean may be. After the root emerges, the two halves of the bean start to separate, causing the coat to crack and in many instances slip off. The next step is the growth of the stem, which is simply a continuation upward of the root. This stem as it grows upward forms a loop, and gradually lifts the bean upward. Then the loop straightens out and we have the erect stem. Meanwhile the two halves of the seed have been opening and finally expose two young green leaves which gradually increase in size. The two halves of the bean slowly shrivel up, and the pupils should realize that the food contained in them is used by the developing plant. The development of rootlets and root hairs on the plant should also be noted as germination proceeds. Corn and sunflower seeds may be treated in the same way as the bean and the differences and resemblances in development noted.

If the pupils collect ripe seeds of the stinkweed, lamb's quarters, tumbling mustard, thistle, etc., in the fall they may find out by experiment how many of the seeds will germinate. Half fill a soup plate or a deep lid with moist sand, cover with moist cheesecloth or blotting paper, and set out twenty-five seeds on it. Cover the seeds with a second piece of damp cloth and over this place a lid to prevent loss of moisture. Set in a warm place, and at the end of (1) four days, (2) a week, count the number of seeds which have germinated. Simple experiments may also be carried out to show that for successful germination the seeds require moisture, heat, air and light. Thus a few beans planted in a soil which has been thoroughly dried will not germinate. Others may be planted in a can and set outside the window in cold weather; others may be developed in a dark place; and still others in soil that is kept saturated with water, thus shutting out air from the soil.

For bird study in the fall and winter in this grade the teacher is referred to Chapters III and IV.

GOPHER

The term, "gopher," is commonly applied to four distinct animals in Alberta, only one of which is a true gopher. The most numerous and most widely distributed animal is the one popularly called the flickertail or yellow gopher (technically Richardson's spermophile). This animal, when full grown, is about a foot long and tawny in color. It is the common gopher of the open prairie of the southern part of the province, and as far north as the Battle river. It is the most destructive of the gophers. In the prairie country there is also found the striped gopher, also known as the Minnesota gopher and the striped ground squirrel (technically striped spermophile). This animal is about the same size as the previous species. The back is dark brown in color with stripes of dull yellowish white. It gradually disappears where land is brought under cultivation. In the bushy and thinly wooded districts of central Alberta we find the whistling gopher, also known as the grey ground squirrel or bushy tailed ground squirrel (technically Franklin's spermophile). The head is grey, the back yellowish brown mixed with grey, and the tail greyish and squirrel-like. It is slightly larger than

Richardson's spermophile. Lastly we have the true gopher, which is the northern pocket gopher, called also the grey gopher, and incorrectly known as the mole. This little animal is only about seven inches long and is dark grey in color.

The gophers are all burrowing animals. The claws are particularly adapted for that purpose. The flickertail and whistling gopher build the tunnels at an angle, enlarging one section for a den, and running two or more other tunnels to the surface. It thus often happens that when water is poured down one entrance to the burrow, with the idea of drowning the inmates, the gophers will come out through one of the other tunnels. These two species and the striped gopher do not carry the soil out of the burrows in their cheeks. The striped gopher digs a very shallow burrow, which is in the form of a horizontal tunnel only a few inches below the surface. The pocket or true gopher makes much more extensive burrows than do the other species. It carries the soil from the tunnel in the pockets in its jaws and forms many mounds of finely pulverized soil.

The gophers do immense damage by their destruction of the young plants of all the cultivated grains as well as vegetables. The most damage seems to be done along the edge of the field, particularly if the field is near broken or unused land. In some cases the gophers make runways some distance into the field, along which at different points, they dig burrows which extend only a few inches under the surface. These are used for protective purposes in case the animals are taken by surprise. In the fall months the gophers carry grain seeds to their burrows and store them up for use in early spring before the plants are above the ground. It has been established that a gopher will destroy two or three bushels of grain in a season. The animals hibernate until March. There are usually eight or ten young in a litter born in May. The burrowing of the pocket gopher often destroys the roots of growing plants. The burrows make it difficult to cultivate the land and gather the harvest.

The gopher has many natural enemies. The hawks, owls, coyotes and badgers destroy the greatest number. Weasels, foxes, dogs and cats also kill the animals when the opportunity presents itself. The indiscriminate destruction of hawks in Alberta has been one of the factors which has made it a difficult task to keep the gophers under control. (See Chapter IV).

RABBITS

In Alberta we find rabbits and hares, although both are popularly known as rabbits. The native rabbits—the northern varying hare and the jack rabbit—are hares, but some of the pet rabbits belong to a species imported from Europe and are true rabbits. The distinction between hares and rabbits is not necessary for Grade III pupils. The teacher may, however, be interested in the ways in which the animals differ. The true rabbits are smaller than the hares and have shorter legs and ears. They burrow into the soil while the hares do not. Young rabbits differ from the hares in being born blind and without practically any hair. The features outlined in the rest of this section deal with our native species.

The northern varying hare receives its name from the fact that during the summer the general coloring is reddish brown with the under part of the body white or yellowish, while in the winter it is almost white except a few dark hairs near the ears. The change in color is believed to be for the purpose of providing protection for the animal from its enemies. The short white fluffy tail of the animal has resulted in its being called cottontail in the west, although in the east the name is applied to a different species. The jack rabbit is larger than the cottontail and has longer ears and legs than its cousin.

The rabbits live in the bushes and shrubs beneath a cover of grass. They make winding runways through the bushes by cutting

off the grass. At times the deserted burrow of another animal is used as a home. The nest of the rabbit is often lined with rabbit hair. There are from three to six young in a litter, and two or three litters a year. The pupils should note the way in which the long ears are lifted in order to detect the slightest movement of intruders. They should also observe the long, strong hind legs which enable the animal to take long, quick jumps. Its habit of rising on its hind feet to survey its surroundings should also be drawn to their attention. They can also observe how noiselessly the rabbit moves, the thick pads of hair on the soles of the feet being an adaptation for this purpose. If they can examine the hair of the animal they will find the hair next the skin soft and thick to provide warmth, while the other hair is longer and stiffer, probably as a protection when passing through brush and also to shed the rain.

The food of rabbits consists of grass, vegetables and tender grain in the summer, while in the winter it has to depend largely upon the soft bark and buds of shrubs and trees. Most of the feeding is done at night. Pupils can easily see the chisel shaped teeth which are used in gnawing. Rabbits have many enemies, of which coyotes, weasels, foxes, hawks, owls and snakes take first rank. Some of its enemies depend upon the habit of the rabbit of running in large circles when pursued. The rabbit depends almost entirely upon its speed for protection. At times it remains motionless or "freezes" and thus is difficult to detect. In some instances it strikes a small enemy a fierce blow with its hind feet.

MUSKRAT

The muskrats are much more common along the creeks and ponds north of the North Saskatchewan river than in the southern part of the province. The animal shows many adaptations for living in water. The hind legs and toes are much longer than the front ones. The space between the toes of the hind legs is occupied by webs and hairs, thus making the hind legs well adapted for swimming. The long, flat tail is used as a rudder to assist in steering the animal while swimming. It also acts to some extent as a propellor. The tail is also used to splash the water as a signal to its comrades that danger is near. If the fur is examined closely it will be seen that there is very fine fur next the body, which prevents the water from reaching the skin of the animal, no matter how long it remains in the water. The muskrat is an excellent diver, and like the beaver is able to stay under the water for some minutes. When swimming the only parts seen above the surface of the water are the end of the tail, the nose, and the top of the head.

The food of the muskrat consists largely of the roots of water plants, although it also eats clams, fish and insects. The teeth are similar to those of a rabbit. Most of the food is obtained at night, and owing to its rather slow movement on land the animal rarely travels more than a hundred yards from its home. The summer home is often built in a bank along the edge of a stream. The entrance is through a slanting tunnel under water although there is usually an opening into the air to provide ventilation. The den itself is above the level of high water. In some instances there is a land entrance, well hidden from the view by grass. A number of muskrats often unite to build a winter home. This is erected out in the stream, and is constructed of mud and reeds. As soon as it is a few inches above the water a tunnel is dug through the rushes under the water level. When completed the home appears as a dome with a small opening for air. A large room often lined with leaves is inside the dome but above water level. Since the muskrat neither hibernates nor stores up food for winter it is able to do down into water and obtain its food at the bottom of the pand while protected from its enemies by the ice at the surface.

The worst enemy of the muskrat is the mink, which can follow the animal into its burrow. Weasels, wolves, foxes, hawks and owls

also prey upon the muskrat. The flesh of the animal is eaten by the Indians. The total value of muskrat skins is greater than the catch of any other fur, not only in Alberta but also in Canada. It is used principally for coats and cloaks. When the long outer fur is removed and the soft under fur dyed, the latter is sold as Hudson Seal. The animals are often caught in the spring in steel traps placed under the water near the entrance to the den. The Indians sometimes spear them through the ice in the winter, and also kill them in their winter quarters by running a spear through the dome of the lodge.

INSECTS

The habits of the grasshopper may be studied on the school grounds on a sunny day in early September. Live specimens may also be placed under a glass tumbler with some fresh grass and the pupils may then note some of the interesting features about the insect. If they observe the insect feeding, they will see that it often grasps the edge of a blade of grass or leaf with its front feet, and then cuts downward along the edge of theleaf. At other times a hole is made in the centre of the leaf. The other details in connection with the grasshopper will be found in Chapter V. In the same chapter will be found instructions for killing and mounting insects. The cabbage white butterfly, the ladybird beetle (lady bug), the dragonfly, the bumble bee, and the housefly may be obtained in September and studied during the winter. A better method is to capture the insects and instead of killing them, place them in a glass sealer with mosquito netting at the top, and study the live insect.

Galls are interesting subjects for study in this grade. One often finds spherical enlargements on the stem of the golden rod. These are the so-called spherical golden rod galls. A small fly made a hole in the stem of the golden rod plant, and laid an egg which hatched into a small white grub. This grub, in some manner yet unknown, sets up an irritation in the stem so that the stalk grows more rapidly at that point and forms a spherical knob. This gall provides both food and shelter for the insect. When the larva is full grown it changes into a pupa, and later a small fly cuts a hole through the gall and escapes. If several galls are obtained in the fall, some may be cut open to show the white grub in the centre. Others may be placed in a sealer covered with mosquito netting and kept in the cellar throughout the winter. In the spring the fly which comes out of the gall may be examined.

We sometimes find on the golden rod stem a long spindle-shaped gall. In this case a small grey and brown moth lays the egg, and the caterpillar lives within the stem. When the caterpillar is full grown it cuts a small oval opening at the top of the gall but leaves a plug of the cut pith in the opening. It then changes into a pupa and when the little moth comes out of the pupa case it easily pushes the pith out and goes out into the air. The moth usually emerges in the fall.

A third type of gall found on the golden rod is often noticed in July or August. The leaves at the tip of the stem form a dense mass like the petals of a flower of the dahlia. If they are examined closely one will find small grubs which later change into flies.

The willow cone gall is dealt with under the willow tree in Chapter IV. The small lumps found on willow leaves during the summer are, in many cases, the galls of saw flies. The leaves of the prairie rose sometimes show small spiny galls, not more than one-quarter inch in diameter. Clusters of large spiny galls are often found on the stems and twigs of the same plant. When these are kept over the winter, black flies will emerge in the spring.

SPRING FLOWERS

The purple anemone (pasque flower, crocus) is treated in Chapter V. In June the sandy land of the southern part of the

province is bright with the large yellow flowers of the buffalo bean, often called the golden pea. The plant usually grows to a height of from one to two feet. The stem is coated at first with fine glossy grey hairs. Each leaf is composed of three leaflets. The leaves are folded at first but gradually open. The flower buds then appear at the ends of the branches followed by the golden pea-shaped flowers. In July the seeds are ripe and are contained in flat curved pods, each of which holds ten to fourteen seeds. The buffalo bean is a perennial. If the pupils dig up a plant in the fall they will see the thick roots which have food stored up in them to give the plant an early start in the spring.

EARLY PURPLE VIOLET

Of the many species of violet found in our province, the early purple violet has probably the most conspicuous flowers. The plant, like the violets in general, thrives best in moist places near creeks or in low pasture land. The long flower stems lift the purple blossoms above the heart-shaped leaves. Examination of the flower shows that one of the petals, the lower one, is larger than the others. This large petal extends back into a spur which contains the nectar. If the pupils watch the bees visiting the violet flowers they will notice that the insects use the broad petal as a platform on which to rest when seeking the sweets at the base of the flower. At the base of the plant may sometimes be found a second kind of flower, which is quite inconspicuous and never opens. In this way the flower makes certain that it will be self-pollinated.

FALSE SOLOMON'S SEAL

There is nothing "false" about this beautiful plant except its name, which has been applied to it to distinguish it from another plant to which it bears some resemblance. False Solomon's seal is a plant of the woods and the moist lands. The wand-like stem is from one to two feet high. Scattered along the stem in an alternate arrangement are the broad oblong, lance-shaped leaves, which are from three to six inches long. The small, faintly fragrant, cream or white flowers are found in great clusters at the end of the stems, and look like feathery plumes as they are swayed to and fro by the gentle breeze. In July the delicate flowers give place to clusters of red-spekled berries which are much sought after by the birds.

TALL LUNGWORT

This is the most conspicuous blue flower of early summer in many parts of the province. The children have applied the name bluebell indiscriminately to two species of lungwort and to the familiar harebell. The plant under consideration grows from one to three feet high. The thin dark green leaves on the upper part of the plant are pointed like a lance, while the leaves at the base are rounded. The buds of the drooping flower clusters are pink in color, but as they open the funnel-shaped flowers turn blue.

DWARF BUTTERCUP

This yellow-flowered plant of the prairies is found growing in dry ground in May and June. It is a low plant, rarely exceeding eight inches in height and often flowering when it is not more than half that height. The bitter taste of the stem and leaves protects the plant from the grazing animals. It is well to warn the pupils against biting the plants as blisters are likely to result if they do so. The numerous white, fibrous roots enable the plant to utilize all the moisture near the surface of the soil. The stems are erect and covered with hairs. When the pupils examine the hairy leaves they will find that the leaves are not all of the same shape. The leaves at the surface of the ground are round, have rounded teeth along their margins, and are attached to the stem by long stalks. Higher up on the plant the leaves are almost divided into distinct pieces and

spring directly from the stem. The golden-yellow flowers at the end of the stems and branches are quite conspicuous.

WEEDS IN THE GARDEN

One of the earliest flowering weeds which the pupils are likely to find is the familiar **stinkweed,** one of the worst weed pests in the province. The small, white flowers will often be seen during April and by the beginning of June the notched flat seed pods which serve to distinguish the plant are formed. **Lamb's quarters,** popularly known as pigweed, is another common garden weed. It grows quite rapidly and at maturity is from one to four feet high. The flowers are green in color. When young this plant makes excellent "greens" which rival the cultivated spinach. The **shepherd's purse** is found in nearly every garden. The rosette of leaves spread over the surface of the ground resembles that of the dandelion. The pupils, by comparing the two plants, will see that the leaves of the shepherd's purse are light grey in color while those of the dandelion are light green. The small flowers are white in color. The conspicuous seed pods form the easiest method of identification of the plant. They are flat, triangular in shape with a motch in the top, and are distinguished by their small size from those of the stinkweed. Each pod contains 15 to 20 seeds. It will be an interesting problem to estimate the number of seeds on a specific specimen of the plant. **Blue bur** or stickweed is easily identified by its extremely small pale blue flowers, which are arranged in long clusters and are succeeded by small green burs that turn brown when ripe. **Wild barley** (skunktail grass, squirrel tail grass and incorrectly called foxtail), grows in tufts from six to fifteen inches high. The mature plant bears a close resemblance to the cultivated barley and is immediately identified by the bristly awns. Many other weeds will no doubt be found in practically any garden.

In dealing with the damage done by weeds the teacher may place a piece of lamb's quarters under a tumbler and have the pupils notice that moisture forms on the sides of the tumbler after a time. The robbing of the land of moisture by the weeds may thus be brought out. They also take up plant food from the soil at the same time. They may note the way in which the weeds crowd out the cultivated plants, because they start growing before the garden seeds are planted. Some of the larger weeds, for example, lamb's quarters, shade the useful plants. The most evident damage done by the weeds from the pupils' standpoint is doubtless the fact that it requires much hard work to keep the gardens free from them. The children's attention may also be drawn to the caterpillars and other harmful insects which are often found on the weeds and later attack the cultivated plants.

BIRDS

The identification and interesting features about many common birds of the province are given in Chapters III, IV and V. We shall deal here with the ones mentioned on page 23 of the Course of Studies. If the teacher purchases a few of the Audobon Bird Leaflets listed in the Appendix, she will have excellent supplementary reading for bird study.

BLUEBIRD

With the return of the robin and the bluebird and the meadowlark in April, the children believe that spring is surely here. Our western bluebird lacks the reddish breast of its eastern cousin, although the latter is sometimes found as far west as Alberta. The male birds usually return first, but are soon followed by the more dull-colored females. The birds prefer to build their nests in a hole in a tree, in an outbuilding or in a bird-box. The pupils may attract the bluebirds by building bird houses. A box with about eight or ten inches as each dimension is a good size. Make an opening not more than 2½ to three inches in diameter in one side of the box a few

inches from the top. Make certain that there are no projections from the ends of the box upon which the English sparrow may light. These pests will rarely attempt to inhabit a box which lacks a threshold. Nail the box on a post about ten feet from the ground, and place some barbed wire or a piece of tin around the post to protect the nest from cats. The bluebirds take little pains in building the nests, a small quantity of grass or hay with a few feathers being all that is required. The four or five eggs are bluish white in color. While the female is incubating the eggs the male bird may often be seen carrying insects to his mate. The young birds have spotted backs and breasts, and are fed entirely upon noxious insects. The adult birds feed largely upon insects but are also fond of wild berries. The bluebird differs from the robin in capturing insects, in that it rarely stays any great length of time on the ground in search of them. It prefers to perch upon a fence or wire, then drops down to the point where the insect is.

MEADOWLARK

If the people of the prairie were asked to choose a bird as their emblem, there is little doubt that the meadowlark would be their choice. The clear, flute-like notes attract particularly the attention of people from other lands where the bird is unknown. The meadowlark of the eastern provinces and states resembles the western meadowlark in habits, but its song is much inferior to the bird of the plains. The yellow breast, with the crescent bib, is an easy recognition mark. The nest is always built on the ground, and in many cases has a dome of grass to protect it from prying eyes. In many cases the female bird appreciates the fact that the color of her feathers resembles that of her surroundings, and does not fly off the nest until the intruder is but a short distance away. The eggs number from four to six, and are white speckled with brown. The yellow color on the underparts of the young birds is much duller than on the adults, and the black crescent is usually veiled with white. The western farmer has no more valuable ally in his endeavor to control insect pests than is the meadowlark. Young grasshoppers, cutworms, wireworms, and many destructive caterpillars are destroyed in great numbers by the birds.

FLICKER

The flicker is the commonest woodpecker in our province. Two popular names given to the bird, the yellowhammer and the golden-winged woodpecker, give us a clue to one of the easiest methods of identifying the bird, namely, the bright yellow under-surface of the wings and tail. Black polka dots on the breast and bright red band across the back of the neck are also distinctive. The tapping of the bird on telephone post and trees is familiar to the children wherever the bird is found. It uses its sharp, strong beak as a chisel in making a circular opening into a hollow tree or post. It then excavates a vertical passage and lays the pure white eggs on the chips. The young flickers are probably the ugliest creatures in the bird world, as they lack feathers and have a wrinkled skin. The deserted nests of the flickers soon find new tenants the next year. The sparrow hawk, the tree swallow, the chickadee, the screech owl are glad to occupy a dwelling provided for them by their friend. Although the flicker is a woodpecker and lives almost entirely upon insects, it obtains comparatively little of its food by searching for it on the trees. Its favorite food is ants, and if we accidentally flush the bird from the ground we are almost certain to find a colony of the ants close by. The long, barbed tongue, with its sticky saliva, proves a most effective aid to the bird in obtaining its food.

ANTS AND ANT HILLS

These interesting insects are found in every district and may easily be studied by pupils in this grade. While there are many

species of ants which are destructive to trees by boring into the bark, we shall confine our statements to the ones found on the ground. If an ant hill is disturbed by poking a stick down the centre of the hill, the pupils will notice that many of the ants will immediately rush to the disturbed area and carry away small white oblong bodies to places of safety. These are the young (larvae and pupae) and not the eggs, as many people believe. The eggs are very small, usually not larger than a pinhead. The ants commonly seen in the ant hills are the worker ants. If the hill is carefully dug up one may find the queen of the colony, which is considerably larger than the workers. In late summer or early autumn one often sees great numbers of flying ants. These are queens and male ants. After the mating, the queen returns to the ant hill and either destroys her own wings or has this done for her by the workers. Thereafter she never leaves the ground but devotes her energies to laying eggs.

The children's attention should be drawn to the fact that the ants are very strong, since they are often seen carrying things which are heavier than themselves. They will also be interested in the co-operation between the workers. If a worker finds a larger ant (dead) or dead caterpillar or some other food that is beyond its own power to carry to the ant hill, it enlists the services of other ants. The pupils can often see several ants at work on the one piece of material. Their habit of saluting one another by stroking the antennae should also be noticed. The ants of one colony will not permit any strangers to enter their home. If you find that ants are traveling from one mound to another these mounds are connected by underground passages and really constitute one colony. If the children are so fortunate as to find an ant hill in which there are two species of ants, they have discovered the home of a slave holder ant. This ant makes war upon other species, brings back the larvae and pupae of the conquered to its own colony and when the latter develop they act as "slaves" and do most of the work in the ant hill.

The pupils will often find numbers of ants on stems of golden rod and other plants. If these plants are examined closely they will usually be found covered with plant lice (see Chapter IV). These insects secrete a fluid known as honey dew, which is greatly relished by the ants. The ants climb up the plants, stroke the backs of plant lice with their feelers and the lice exude drops of yellow liquid. The plant lice are often called the cows of the ants. In some cases the ants carry the young plant lice to their hills, keep them over the winter and in spring place them on plants. The ants, in an indirect way, are thus enemies of man by their protection of a noxious insect.

FROGS

Every slough and stagnant body of water is the home of these interesting animals. One of the interesting things which the pupils can note about the frog is its ability to change its color to put it in keeping with its surroundings. If one is kept for some time on green grass in a sealer, it will appear green. If now it is transferred to another sealer which has grey paper in the bottom it will tend to show a greyish color in a few hours. The long, webbed hind legs are well adapted for swimming. The children should also notice that the hind legs enable the frog to take long leaps. The way in which the long tongue attached to the **front,** not the **back** of the lower jaw, can dart out with gread speed and capture insects, should be observed. In the fall the frogs burrow down to a considerable depth in the mud to escape frost and hibernate. Very little air is required during this period, as respiration and circulation are both very feeble. The frogs' eggs are laid in a large jelly-like mass along the edge of the sloughs in the spring. There is no simple method of distinguishing them from the eggs of the salamander. They differ from those of the toad in the fact that the latter are arranged in long strings, while those of the frog are in a mass.

If teachers wish to follow the early stages of development of the frog from the fertilized egg they should observe two or three precautions: (1) Do not put a mass containing more than 20 eggs in a sealer of water. If you do so there will not be sufficient food or air for the young tadpoles. Some will die while others may be devoured by their stronger brothers; (2) Use slough water and change it once a week; (3) Place some water weeds in the jar, and leave the jar in the sunlight for a few hours each day in order that oxygen may be set free into the water for the use of the tadpoles. Where these precautions are carried out it should be possible before the school closes in June to see the following features: (1) The eggs become larger and turn almost entirely black; (2) The eggs lengthen and assume the shape of small tadpoles with large heads and no legs; (3) The tadpoles make their way out of the jelly and remain quiet until the mouth has developed; (4) The tadpoles move freely about, using their tail to drive them through the water. They start feeding upon the water plants. For the later stages of development the best plan is to have the children watch the slough for the tadpoles and have them bring in specimens in water in various stages of development. Some will show the hind limbs developed; others in a later stage may show the two pairs of legs and have only a very small tail. The use of the legs of the tadpoles in swimming may readily be seen if they are kept in a sealer of water for a few days. In order to impress the lesson of kindness to animals upon the pupils, the teacher should insist upon the return of the tadpoles to their native haunts after they have served their purpose in the school.

BUTTERFLIES AND MOTHS

DIFFERENCES BETWEEN MOTHS AND BUTTERFLIES

The chief difference between a moth and a butterfly may be shown by having each child obtain a specimen of some small grey moth or "miller" and also a specimen of a butterfly. Examination of the ends of the feelers will reveal the fact that there is a knob or wide part at the tip of the butterfly's feelers, but this is not found on the feelers of the moth. This is the only difference in structure of the body of the two classes of insects that always obtains. For a distinction in the field have the pupils note that when a moth lights on a plant it either spreads its wings out horizontally or folds them flat on its back. The butterfly may flatten its wings out for an instant, but if it remains any length of time on a plant the wings stand on end in a vertical position or at a large angle. Butterflies fly only by day, and most moths fly only at night. A few species of moths, such as the geometrid (measuring worm moth) fly largely by day.

IDENTIFICATION OF SOME COMMON BUTTERFLIES AND MOTHS

The following details may prove of help to the teacher who has difficulty in identifying butterflies and moths brought in by the pupils. It should be remembered, however, that there are hundreds of species of moths and butterflies in our province. Space forbids giving the characteristics of more than a few of the common and easily identified species.

MOURNING CLOAK BUTTERFLY

This is the first dark colored butterfly seen in spring. The dark brown (almost black) wings have a broad yellow border, and inside the yellow border is a row of blue spots.

MILBERT'S TORTOISE SHELL BUTTERFLY

This butterfly is also seen very early in spring. It is smaller than the Mourning Cloak Butterfly. Wings are brownish black with a broad orange band between the inner and outer margins of the

wings. There is a row of small blue spots on the hind wings on the outer margin.

TIGER SWALLOW TAIL BUTTERFLY

Largest butterfly with yellow wings found in province. Easily recognized by dark tail-like extension on each hind wing. Wings are bright straw yellow with a very wide black margin in which there is a row of yellow spots. This species sometimes appears in a second form which has black instead of yellow as predominating color on wings, but shows the marginal row of yellow spots.

SULPHUR BUTTERFLIES

There are several butterflies of medium size which have yellow as the predominating color on the wings. These are popularly called sulphur butterflies. The commonest species is the **roadside** or **clouded sulphur** butterfly. This butterfly has a blackish brown border along the edge of greenish-yellow wings. Feelers and upper margins of front wings are pink. There is a black dot on each of front wings and an orange dot on each of hind wings. Dark border on front wings of female wider than on male, and has row of yellow dots which are absent in the male. Another sulphur butterfly, the **orange sulphur,** closely resembles the roadside butterfly but has orange instead of greenish-yellow color predominating on wings.

BANDED PURPLE OR WHITE ADMIRAL BUTTERFLY

Is one of most conspicuous large dark-colored butterflies in July. Broad white band which runs across middle of four chocolate black wings serves for identification. There are several purple spots near the outer margin of the hind wings.

MONARCH BUTTERFLY

A large butterfly, with a wing expense of 4 to 4½ inches, found to the greatest extent in southern part of province. Orange-brown wings have black borders and veins, with two rows of white spots on the dark borders of wings. Monarch is only likely to be confused with smaller butterfly, the **Viceroy,** which mimics coloration of larger butterfly. Viceroy can be easily distinguished from Monarch by black band which runs transversely near centre of each of the hind wings.

SILVER SPOT BUTTERFLIES

Brown butterflies, which are very common from late June until August, are often known as **fritillaries.** The writer prefers the name silverspot, which is used by teachers of Nature Study. There are several species of silverspots, which vary in size, but all show silvery spots on **lower** side of wings. Upper side of wings is brown and has numerous dark spots scattered over it.

CABBAGE WHITE BUTTERFLY

Is frequent visitor to practically every garden where cabbage, cauliflower and turnips are raised. There are several varieties of the cabbage white butterfly. In the most typical form it has the upper side of the wings dull white with a greyish-black patch across the apex of the front wings and a spot of the same color in the centre of the front wings and on the front margin of the hind wings. Female has two spots instead of one on each of front wings. Under part of hind wings are pale yellow. Occasionally we see the "spotless form," which differs from the typical form in having no spots on the wing.

There are two other white butterflies with which the cabbage white butterfly may be confused. The **checkered white** is easily distinguished from the cabbage white because it has **several** greyish-black marks on the wings. The **mustard white,** sometimes called the **grey-veined white,** is more commonly found on mustard plants or in the woods than in gardens. The veins very rarely show spots in the

centre. Veins of the wings, especially on the lower side, are greyish and thus distinguished from the cabbage white butterfly.

MEADOW BROWN BUTTERFLIES

Large drab butterflies also known as the **greylings,** found most commonly flitting around tall grass in July or August. Color usually a dull brownish-grey. Eye-like spots on wings quite readily enable one to distinguish them. Are usually two of these spots on each of front wings. Color of centre of the spots is often lighter than that of the outer part.

BLUE BUTTERFLIES

These small butterflies are among the daintiest forms of insect life. Upper surface of the wings is blue, while lower surface is usually pale ash grey dotted with many spots.

MEASURING WORM MOTHS

Caterpillars of different species of these moths follow practice of not crawling along ground by means of their legs as do ordinary caterpillars but loop the hind part of body towards the head and thus move forward almost their own length at one time. Popular name, "measuring worms," has been given to these caterpillars. Adult moths have usually white as predominating color on wings, and often have wings covered with yellowish spots. The moths vary in size and in many instances fly by day.

CECROPIA MOTH

Is one of the most beautiful of the large moths of the province. The wings sometimes expand five inches. The ground color of the wings is greyish-brown. Near centre of each wing is a crescent shaped white spot bordered with dull red. A white band margined with dull red crosses each wing.

SPHINX OR HAWK MOTHS

These moths are rapid flying insects, with thick bodies and long, rather strong wings. Are sometimes called "humming bird" moths. Are often found poised over flowers in the evening sipping the nectar with their exceptionally long tongues. Front wings are usually grey in color and blend with color of the bark of trees on which moths rest during the day. The under wings sometimes show rose and crimson colors.

FOREST TENT CATERPILLAR MOTHS

Life history of this destructive insect is given in Chapter IV. Yellowish-brown moths; are seen fluttering around the trees during the day and around lights at night in latter part of July in central part of province.

LIFE HISTORIES OF SOME COMMON MOTHS AND BUTTERFLIES

MOURNING CLOAK BUTTERFLY

This is usually the first butterfly seen in the spring, as it passes the winter in the adult stage in some sheltered spot. The eggs are laid in clusters on the willow or poplar trees in May. The caterpillars are velvety black in color with a row of conspicuous red spots along the middle of the back. There are many long spines on the body of the caterpillar. The caterpillars greedily devour the leaves of the trees on which the eggs are laid, and shed their skins several times before reaching maturity. The caterpillar, when full grown in July, is about two inches long. The full grown caterpillar suspends itself from a twig by a silk button, its skin splits open, and a dull colored chrysalis, much shorter than the caterpillar is seen. The pupa stage usually lasts about two weeks, then the adult butterfly

emerges from the pupa case. Its wings at first are small and limp, but as it hangs by its legs from the twigs its wings expand rapidly, dry and become stiff. In some cases a second brood is raised, the caterpillars of this brood being found on the willows and poplars in September.

MONARCH BUTTERFLY

Teachers who are in districts in the southeastern part of the province, where the milkweed is abundant, will find the monarch butterfly an excellent subject for study. If the pupils examine the milkweed plant early in September they will probably find caterpillars about two inches long. The head is black striped with black, while the greenish-white body has narrow black and yellow cross stripes on each segment. On two of the segments are a pair of whiplashes which the caterpillar jerks back and forth when disturbed. The caterpillar should be left on the plant and placed in a large sealer with mosquito netting over the top. The caterpillars suspend themselves from the stem as in the case of the mourning cloak caterpillar, but change into a chrysalis unrivalled in coloring in the insect world. The oblong pupa case is sea-green in color, with a band of pure gold near the top and small spots of gold on the lower part. The chrysalis gradually changes to a bluish-green and in about two week's time the butterfly emerges. The monarch butterfly is remarkable for the fact that it migrates to the southern part of the United States. In the spring the butterflies start their march northward as the milkweed plant comes into leaf. The eggs are laid on these plants, for the caterpillar refuses to eat any other type of leaf. The butterflies from this brood of caterpillars in turn continue the migration northward, laying their eggs as far as they go. We usually find the butterflies in Alberta in July. These adults are believed to die off later in the season.

CABBAGE WHITE BUTTERFLY

This butterfly is an undesirable emigrant from Europe. It first appeared in North America in the city of Quebec in 1860 and is now found throughout the continent. It has starved and driven out of the gardens the native white cabbage butterflies and forced them to live on wild plants. The yellow eggs are laid on the leaves of the cabbage, cauliflower and other cruciferous plants. The caterpillar is velvety green in color with a faint yellowish stripe down the back and on each side. It is often found in the heads of plants which have been removed before the chrysalis stage has been reached. The caterpillar eats large irregular holes in the leaves of the plants upon which the eggs are laid. When full grown the caterpillars seek shelter under a leaf, stone or board, and change to an inconspicuous chrysalis. The chrysalis often takes the color of the substance against which it is hung. The cabbage butterfly is two-brooded in Alberta, the second brood usually passing the winter in the chrysalis stage.

MILBERT'S TORTOISE SHELL BUTTERFLY

This brownish butterfly, like the mourning cloak, hibernates in the adult stage and is therefore seen very early in the spring. The small green eggs are laid on the nettle plant. The caterpillars are very sociable little creatures and are often found side by side eating the edge of the nettle leaf. The body of the caterpillar is black above, while the sides and lower parts are greenish-yellow. It is covered with bristly spines. The caterpillar, when full grown, is about an inch long. It weaves leaves of the nettle together for a home for the chrysalis, which is pale brown or golden-green in color. The coloring of the adult has already been described.

CECROPIA MOTH

Teachers who wish to arouse the interest of the pupils in the beautiful moths described by the late Gene Stratton-Porter in her

well known novels, ("Girl of the Limberlost," "The Harvester," etc.) should write in November to Ward's Natural Science Establishment, College Avenue, Rochester, New York, for a price list of living pupae. The cocoons of the cecropia usually cost about seven cents apiece. One of the cocoons shoulld be broken open to show the children the layers of tough silk which were spun by the large green caterpillar before it changes into a pupa. They may also notice the shape of the brown, oval pupa with the wings folded tightly in a case. The other cocoons should then be placed in a box covered with mosquito netting and kept throughout the winter in a cool place. They should be soaked with water from time to time in order that the pupa may not dry up. The moths are likely to emerge from the cocoons any time from April until July. When they first come out of the cocoon they are quite small, damp and wrinkled, but in the course of a few hours the wings dry and spread out, and the furry body becomes fluffy. The adult moths ordinarily live not more than two weeks, during which time they eat no food. The writer has tried the experiment of providing sugar dissolved in water as food for the moths, but has found that while they sip some of the syrup, they do not live any longer than those for which no food is provided.

The eggs of the cecropia moth are laid upon the leaves of almost any of the forest trees other than the evergreens. The caterpillars vary in color after each moult of the skin, the full grown caterpillar about three inches long, being bluish-green with orange, yellow and blue tubercles or lumps on the top and side of each segment of the body. The caterpillar reaches its full size in September and then proceeds to spin its cocoon, usually on the branch of a tree. The silk at one end of the cocoon is spun lengthwise instead of crosswise, leaving a valve through which the adult moth can make its way out in the spring. The silk is spun from a gland in the lower lip. If the children find a caterpillar in the fall it will be interesting for them to place it in a sealer on a twig of the plant and watch it spin the cocoon.

SPIDERS

September is probably the best month for the study of spiders. Have the boys of the class collect all the live spiders that they can find, and also bring in the spider's eggs, which are found in little sacs. These egg sacs are sometimes hung in the web, or in cracks under boards or stones. The pupils may sometimes see the spiders carrying the egg sacs with them. The live spiders may be put under inverted tumblers for observation. The pupils may first be asked to tell where they have seen spiders (on windows, ground, leaves of trees, etc.) They may then count the number of legs of the spider and find that it has two more legs than have flies, butterflies, moths, bees, ants and other insects. Next place a piece of stick about ten inches long in a potato or apple and set it in a dish of water. Place a spider on the top of the stick and have the children notice its movements. It will first run down the stick but when it finds that it is on an island it will retrace its steps. After several more attempts to escape, the children will notice that the spider is spinning a fine silken thread from spinnerets near the rear of the abdomen. The fine thread floats out into the air until it is caught caught on some piece of furniture. The spider tighten and fastens the thread and then runs across the suspension bridge and escapes.

If the boys find a spider's web which looks like a wheel (orb web), have them capture the spider by placing a box on one side of it and the lid on the other and then bringing the two together quickly. Place the spider in a large pickle jar covered with netting and have the pupils catch flies and mosquitoes to feed it. It will thus be encouraged to spin its web. The spider first spins the straight lines that form the spokes of the wheel. These spokes are made of inelastic silk which is not sticky. Next the spider starts at the centre and stretches threads in a spiral from spoke to spoke as far as

it can reach. When it arrives at the outer edge of the web it uses this first set of spiral threads to walk on while it forms a spiral of sticky threads on which insects will be caught. It destroys the first set of spiral threads as it works its way towards the centre.

Have the pupils watch a spider's web and see where the spider stays. In some cases it is found at the centre of the web, while in other instances it often hides in a folded leaf or some other refuge. Notice the way in which it runs along one of the threads and winds a few strands around any entangled insect. In some cases it may be seen to bite the insect. Later it sucks the blood from its victim. The spider never becomes entangled in the web because it is careful to run along the threads which are not sticky.

CHAPTER III.

GRADE IV.

EFFECT OF CHANGE OF SEASONS ON MAN, ANIMALS, PLANTS

In dealing with the relation of seasons to the occupations of people in Alberta, it is well to take up first the effect upon the people in the school district. When the school opens in the fall, harvesting and threshing operations are being carried on. Many men who have come on excursion trains from other parts of Canada to help with the harvest (and see the country) return to their homes when the harvest is over. The men who are employed in building new railway lines and grading roads must cease operations when the cold weather sets in. Exterior work on new buildings must also be suspended and thus bricklayers, carpenters, masons and other mechanics must seek other work. When the harvest is over, many farmers do not want men who have been operating tractors, etc. Farmers' sons who find that there is not sufficient work for them at home in winter often attend agricultural schools, business colleges, technical schools, etc.

On the other hand there are many lines of work in which more people are engaged in the cold weather than during the spring and summer. Coal mining, according to the conditions that prevail in Alberta at the present time, is to a considerable extent a seasonal occupation. Men who have been employed in other lines of work in warm weather, work in the mines during the winter when coal is shipped not only to all parts of Alberta but also to Saskatchewan and Manitoba. Coal dealers employ more men during the winter than during the summer. In the forests, the lumber camps are in full swing during the winter, taking advantage of the snow and frozen ground for easy transportation of the logs to the nearest river. The winter months are also the season of activity for the trappers, who then find many of the fur-bearing animals with "prime fur." Many of the animals are also more easily captured during this season. In the grain trade the men working in elevators and inspecting grain are busier in late fall and winter than during other seasons of the year. In some of our lakes, fishing is confined to the summer months. In a few instances, for example, Cold Lake, fishing is of particular importance in winter because of the ease of transportation of the fish in the frozen condition to the nearest railway station, which may be a considerable distance away.

The preserving of fruit and the storing of vegetables are instances of the endeavor of the housewife to cope with the food problem in the winter. We have also the provision made for the bringing in of fresh fruit and vegetables (e.g. from California) where the climate is milder than our own. The providing of food and shelter for domestic animals may also be mentioned. The difference in the type of sports carried on in the different seasons may be made the subject of an interesting talk.

Under the influence of seasonal changes on streams may be mentioned (1) the rapid melting of the snows of the mountains at the sources of many of our rivers which combined with June rains often results in serious floods. During this period of high, rapidly flowing water the stream carries with it a greater quantity of sediment than at other times, as may be seen by the muddiness of the water after a rainstorm. (2) The drying up of many sloughs during the hot, dry summer. (3) The formation of ice upon the surface in cold weather because the ice is lighter than water and therefore floats. In this connection the pupils should know that in our lakes and deeper rivers the water is only frozen at and near the surface, as may be shown where ice is being chopped and stored for domestic

use or where there is winter fishing. The preparation of plant and animal life for cold weather is discussed in Chapter V.

EVAPORATION AND CONDENSATION OF WATER

Many simple experiments may be carried out which will give the pupils of this grade a clear idea of how moisture gets into the air and how it is removed from the atmosphere. Take two saucers and pour in each the same quantity of water. Place the two saucers in a warm place near the stove or in a sunny window, cover one tightly with a cardboard box, but leave the second uncovered. The pupils will observe that the water disappears more rapidly from the open saucer than from the covered one. Two questions may be answered at this point: (1) Where did the water go? (Into the air). (2) Why did the water evaporate more quickly from the open saucer than from the covered one? (Because the water in the first saucer came in contact with more air than did that in the saucer which was covered).

Next place one saucer of water in a warm place and keep a second saucer containing the same amount of water in a cool place. Have the pupils see for themselves that the water disappears more rapidly from the saucer which is kept in a warm place. This brings out the fact that water will evaporate more rapidly in warm air than in cold air. The pupils' mothers prefer a warm, sunny day to a cold one for washing clothes because they know that the clothes will dry more quickly on a warm day.

On a day when there is a strong wind and when there is little difference between the temperature within and without the classroom, take two cloths of the same material and the same dimensions. Pour into a basin enough water to thoroughly dampen the cloth, and take pains to see that all the water is absorbed. Treat the second cloth in the same way, using the same amount of water. Hang one cloth outside in the wind, and the other in the classroom, and have the pupils note that the one exposed to the wind dries first. This is because more air moves over it than comes in contact with the cloth in the still room. Again we may refer to the drying of the clothes on the clothes line and show why the mothers prefer a day on which there is some wind. Another factor which cannot be easily demonstrated in the classroom, is that water evaporates more rapidly in dry weather than in damp weather. However, we can refer to the slow drying of the clothes on a line on a damp day. The explanation in this case is that the damp air already has in it nearly all the moisture that it can hold.

The pupils have noted so far that water can pass off into the air in the form of a vapor which they cannot see. Let us now consider the way in which the vapor is changed back into a liquid again and the forms which it takes. As a first experiment place a tumbler of very cold water on a desk in the room, but have the children first note that the outside of the tumbler is quite dry. When drops of water condense on the outside of the glass discuss the source from which they came. Deal first with the suggestion which will no doubt be made that the water from the inside of the tumbler actually came through the glass. To disprove this the teacher may refer to the fact that none of the syrup in a jar of preserved fruit comes out through the glass sealer in the months it stands before being used. The water must, therefore, have come from the air in the room, although the water vapor could not be seen there. Why did the water vapor in the air change into a liquid? (Because the air surrounding the tumbler was cooled by the cold water within the tumbler).

We may next take the case of the pupils being able to "see their breath" when they are outside on a cold day. In this instance the water vapor in the air which they exhaled was colled and changed to very fine particles of water which formed a mist. If the children watch a tea kettle which is boiling they will see a clear space between the tip of the spout and the steam which is forming. The hot air

leaving the spout of the tea kettle contains hot water vapor, and the latter cannot be seen any more than the water vapor in the air in the classroom. But this air is cooled when it comes in contact with the air in the room and the water vapor form steam, which consists of thin drops of water similar to those produced from one's breath. Another good example is that of the pupil who wears glasses. If he comes into the warm classroom in cold weather he finds that a thin mist forms on the glass, because the cold glass cools the water vapor in the air in the room.

When the pupils understand that the condensation of the water vapor in the air is caused by cold the teacher may take up the forms in which the water returns to the earth. As the air containing water vapor rises it becomes cooler and the water condenses into fine drops of water which we call clouds. If these clouds become colder they send the moisture down in the form of rain. If the temperature is below the freezing point, the cloud forms not rain or mist, but snow or hail. If the air is damp, when the ground cools down at night it cools the air near the ground so that the water vapor forms as dew on the leaves of plants. Some of the dew consists of moisture which was given out by the plants but could not change into vapor because the air was too cold.

TREE STUDY

The minimum requirements for this grade call for the recognition of six common trees or shrubs by the pupils.

THE WILLOWS

The willows are probably the most widespread of the trees in Alberta. In many cases they grow to a height of but a few feet and should be called shrubs rather than trees. As there are over fifty species of willow in Canada and they hybridize among themselves, it is useless to attempt to name the individual species. If the pupils can resognize willows as a family, nothing further is necessary. The willows are only likely to be confused with the poplars (the cottonwoods), some species of which have leaves quite like those of the willows. If twigs of the plants are examined late in the fall the distinction can be seen easily. The winter buds of the willows have only one scale, while the buds of the poplars have several scales.

A good time to start the study of the willows is early in March. Have the children bring in twigs from the different willow trees and place them in a sealer of water. Set the sealers in a sunny window and watch the development of the flowers. Their attention should be drawn to the brown, varnished layer on the outside of the buds which acts as a protection for the flower within. When the familiar "pussies" burst through the buds, the children will probably find that some of them are quite soft and furry while others do not display these properties to the same extent. The explanation is that the flowers of the willow are imperfect. One tree bears flowers having stamens and no pistils, while the others bear flowers having pistils and no stamens. The two types of flower are never found on the same willow tree. The furry pussies are the staminate flowers and as they develop they will change into color from a silvery grey to yellow. The yellow color is due to the pollen. If the children watch the trees in May they will see the large queen bumble bees visiting the willow flowers to obtain their first supply of pollen and nectar. As these insects travel from one tree to another they carry the pollen to the flowers which bear only pistils and thus enable the latter to produce seed. Have the pupils examine the trees in June shortly before the closing of school and they will see that many of them have catkins containing seeds with fuzzy attachments which soon enable them to float through the air.

When the willow twigs have been kept in the water for two or three weeks they will probably start to develop roots. Twigs that have been flattened to the ground along river banks soon send up

shoots. The willow can thus spread quite quickly even if the seeds do not germinate. The quick spreading of the willow roots and stems through the soil makes it a desirable plant along the banks of irrigation lakes and ponds where it will hold the soil in place. The trees thrive best in moist land. In Canada the wood of the willow is used in making artificial legs, cricket bats and baskets.

One often finds green cones at the tip of the willow stem while the tree is in leaf. If these are broken off and brought into the school room they afford material for an interesting lesson. These cone galls are not a natural development of the willow. A small fly lays its eggs on the twig and the young grub which hatches out in some unknown way interferes with the growth of the leaves and causes them to form a shingle-like arrangement around itself. The cone provides both food and shelter for the insect during the rest of the growing season and the following winter. If the galls are kept in a sealer covered with mosquito netting small flies (the adults of the grubs) will emerge in the early summer. In the Edmonton district the writer has seen single trees bearing over one hundred of these cones. The grub often acts as host to other small insects which live in the outer layers of the cones. Unfortunately for the builder of the cone these insects are sometimes parasites which destroy the host.

THE SPRUCES.

Spruce trees are readily distinguished from other "evergreens" by the sharp pointed leaves which in the two varieties common to Alberta are four-sided. The balsam fir which the beginner is likely to confuse with the spruce has flat, blunt leaves. It is unnecessary to have the pupils in this grade attempt to distinguish the individual species of spruce.

It is wise for the pupils to see the ways in which the spruce trees are adapted to conditions under which they grow in Alberta. If they observe the shape of the tree closely they will notice that it is roughly conical in shape, that the stems are all straight and that the branches grow almost straight out from the main stem and not in the slanting form of many other trees. The conical shape of the tree causes the snow to slide off easily, each branch bending to allow the snow to slide on to the branch below. The pupils will notice that the leaves are nearly all out towards the end of the branches where they can obtain light. The lower branches are longer than the upper ones, and thus enable the leaves to get more sunlight. Have the pupils also note that the trunk of the tree is largest at the bottom, and obtain suggestions as to what help this is to the tree. (Greatest strain put upon the tree by strong wind is at the ground). Illustrate by driving a thin narrow strip of wood into the ground and bending it over from the top. It will break off just at the ground. The pupils should also have drawn to their attention how tough and elastic the branches are, and how readily they spring back into place. They can also notice the resin on the buds, stems and leaves which helps the tree to resist the action of frost and rain. If they stroke the branch towards the tip and then backward from the tip they will feel the pricking of the leaves in the latter case. The small size of the leaves prevents evaporation of much water in the winter months (see Chapter VI). The reason for calling the tree an evergreen may be mentioned. It does not mean that the leaves never fall off, as they can easily tell if they examine the ground under one of the trees. The leaves often stay on the trees several years, but new leaves develop each year, so that when one year's crop of leaves falls off the tree does not have a bare appearance. If they examine a twig in the fall they will be able to see the buds from which next year's leaves will later develop. The spruce tree should be kept under observation in the spring so that the pupils may see the two kinds of folwers on the tree. The flowers which bear the pollen are soft and grow on soft, white stems. The green cones are the flowers in which the seed is formed. They often

remain on the plant for years. If the scales of a mature cone are separated one can see the seeds with the wing-like attachments which enable them to be scattered by the wind. The use of the spruce in the manufacture of paper and as a timber tree may be mentioned. The spruce is the chief source of paper in Canada, and owing to its wide distribution is also used extensively for lumber, mine props, railway ties, etc.

THE POPLARS.

The poplars are found extensively in Alberta, both as native trees and as trees planted for shelter belts and shade purposes. Popular names are applied to the different species of poplar.

The **aspen,** also known as the aspen poplar, white poplar, and smooth bark poplar is almost as widespread as the spruce, being found as far north as the mouth of the Mackenzie River. The leaves are 1½ to 2½ inches long, and are almost spherical in shape. The margin of the leaf is very finely toothed, and the leaf stem is flattened to such an extent that the unstable leaves tremble with the slightest breeze. The aspen is used extensively for firewood in some parts of the province.

The **balsam poplar,** popularly known as the balm of gilead (it is not the true balm of gilead) grows throughout the same wide area where the aspen is found. In Alberta it reaches its greatest development in the Peace River District, where it sometimes grows to a height of 100 feet. The leaves are considerably longer than those of the aspen, being from 3 to 5 inches long. They are also more oval or egg-shaped than those of the latter tree. The bark is rougher than that of the aspen. The balsam poplar is of little value for fuel. Both the aspen and balsam poplar are sometimes used for the manufacture of barrels, boxes and paper. The wood is both light and tough.

The **lance leaf cottonwood** and the **narrow leaf cottonwood** are confined to the banks of the rivers and creeks in the southern part of the province. They rarely grow to a greater height than 30 to 40 feet, and are 1 to 2 feet in diameter. The leaves of the narrow leaf cottonwood are narrow, tapering, and sharp-pointed, and are from 2 to 3 inches long and ½ to 1 inch wide. The leaf might be confused with that of a broad leaf willow. The leaf of the lance leaf cottonwood is wider than that of the narrow leaf, and as the name implies the tip is more drawn out. The margin of the leaf is also more coarsely notched than that of the other species. Neither species is of any commercial value.

The **common cottonwood** is from 75 to 100 feet high and 2 to 4 feet in diameter. It is found in the southern part of the province, and is often planted in shelter belts. The seedlings grow quite rapidly and sometimes reach a height of 20 feet in 6 or 7 years' time. It is used for fuel in some districts. The leaves serve to distinguish the cottonwood from the other poplars in summer. They are roughly triangular in shape, and the length and greatest width are about the same, the base of the leaf is square, and the margin of the leaf is closely toothed. In winter the yellow color of the twigs is a distinctive feature.

THE ALDERS.

The alders, like the willows, are found most commonly along the river banks. In Alberta they usually grow in thickets as shrubs only a few feet high. They are readily distinguished from the other common trees by the fact that the winter buds are stalked, or raised on more or less defined stems. The **speckled alder,** the common form in the province, is usually composed of several stems which spring off close to the ground. The smooth, greyish white bark is covered with white spots. The dark green leaves are roughly oval in shape, are finly notched, and usually show a fine bloom on the

under side. During the winter the oval cones about one-half inch long which contain the seeds are quite conspicuous. The seed resembles that of the coniferous trees in being winged.

SASKATOON.

The saskatoon, a typical western plant, grows from British Columbia to Georgian Bay. It belongs to the service berries, and although it occasionally grows to a height of 10 to 12 feet, it usually is not more than 4 or 5 feet high on the prairie. Since no other species of service berry is found in Western Canada there is little danger of confusing the saskatoon with any other shrub. The pretty white flowers in spring, the rounded leaves with the upper half coarsely notched and the lower half smooth, and the sweet berries are known to the children wherever the plant thrives.

MANITOBA MAPLE.

This is the only species of maple which is native to Western Canada, where it grows rapidly and is able to survive the extreme weather which destroys the other maples. It is found growing native in southern Manitoba and in Saskatchewan and near the North Saskatchewan River in the eastern part of Alberta. It has, however, been introduced into nearly all settled portions of the province, as a shade tree and for sheltered belts. The short trunk, which is usually not more than one foot in diameter, divides near the ground into a number of large spreading branches. The leaves differ from those of all other Canadian maples in being compound, that is there are from 3 to 7 leaflets each from 2 to 4 inches long on a stem. The margin of the leaflets has coarse notches. In the late summer and fall the tree bears clusters of "fruit" from stems about 6 inches long. If the pupils examine the fruit they will see the seeds with a distinct wing attached to each. In passing it may be of interest to note that in the pioneer days in Manitoba, when there was a scarcity of sugar, this tree was sometimes tapped and the sap boiled to make sugar. The sap contains less sugar than that of any of the other maples. The maple syrup and sugar now sold in the stores is the product of the sugar maple of Eastern Canada.

The trees dealt with in the previous sections are purely suggestive and should not be studied if they are not found in the immediate district. Details of the study of many common wild plants of Alberta will be found in Chapters II and V. Recognition of wild plant seeds is dealt with in Chapter V, and the growing of plants from seeds is treated in Chapter II, as is the growing of bulbs. The relation of animals to man is studied under **animal relationships** in Chapter IV; the bat, weasel, coyote and badger are discussed in Chapter V, and the muskrat, gopher and rabbit in Chapter II. The lives and habits of a few more common mammals are given at this point.

BEAVER.

The national emblem of Canada is always an interesting topic of study by the boys and girls. The beavers belong to the group of rodents or gnawing animals, of which we have many representatives in Alberta, such as the gopher, mice, rats, squirrels, rabbits. The four gnawing teeth are from 4 to 5 inches long, but only an inch of the teeth is exposed, the rest being set deeply in the jaw to give extra strength. The hind feet are webbed to aid in swimming. The broad, flat, scaly tail acts as a rudder in steering the animal through the water and also when splashed in the water acts as an alarm signal to other beavers that danger is at hand. The summer home of the beaver is usually built along the edge of a stream. The animals dive and burrow a tunnel under the water and up into the bank, where a den containing a compartment for food and one as a "living room" is constructed. The latter is above the level of the water and has an opening in the top to admit air. The entrance

under water enables the beaver to leave its home and swim for some distance under the surface, so as to give no clue to its enemies as to the location. Some trappers claim that the beaver can remain under water from 4 to 5 minutes.

In order to provide water of sufficient depth the beavers often build dams across a stream. They thus change the water level not only of the stream, but in some cases change the short line of lakes and ponds. If the water floods the lowlands near the bank of the stream it forms the familiar "beaver meadows" which are covered with luxuriant grass. Scattered through the meadows we often find the stumps of trees which were cut down by the beaver. The dams are somtimes built over fallen trees or growing bushes as a foundation. Mud and sticks are used in the construction. The winter "lodge" of the beaver is usually out in the stream near the dam. It is built of mud, sticks and brush, and has a large chamber above the water line. The entrances to this lodge are also beneath the water. Each lodge is occupied by but one family of the animals.

The chief food of the beaver consists of the soft bark of the poplar, willow and birch. The roots of water lilies and the bark of some of the hardwoods, such as the ash and maple, are sometimes eaten. The trees are cut down by the animals cutting from each side of the trunk. When the trees fall the beavers usually dive into the water lest some enemy should be attracted by the noise and creep up on them unawares. The branches of the tree are cut into sizes that can be easily handled. The small twigs are often carried to the lodge in the beaver's mouth, but the large pieces are often rolled to the water's edge. If the trees are some distance from the water the beavers construct canals to float the trees to the lodge or dam. Since the beavers do not hibernate they must store up considerable food for use during the winter. Large quantities of the sticks are sunk in the mud in the stream near the lodge so that the food may be brought to the lodge by swimming under the ice. When the bark has been removed for food the stick is used as an addition to either the lodge or the dam.

SKUNK.

The skunk is an instance of an animal relying entirely upon one weapon of defence, and displaying every confidence in the ability of that weapon to protect its interests. The vile smelling liquid is contained in two small pockets under the tail. The emission of a few drops of this liquid is sufficient to pollute the surroundings for a great distance. The animal seems to display little intelligence and rarely attempts to escape from an enemy. The other animals as a rule give it a wide berth. The great horned owl is probably the only enemy that takes the aggressive and never retreats. The animal is easily trapped. The home of the skunk is often under a barn or in an abandoned burrow of some other animal. The young skunks are very interesting little animals. The writer's first experience with skunks was on a farm when a lad of five. A playmate and himself discovered under a barn what they believed were little black and white puppies, and proceeded to carry their new found treasures to the house. Needless to say, they were soon despoiled of their playthings and forced to don a "change of clothes" without delay. The fur is very valuable and is known to the world of fashion as **alaska sable.** The skung belongs to the weased family and lives largely on mice, insects, and birds which are found in nests on the ground. At times it raids the poultry yard and destroys eggs and young chickens.

CHIPMUNK.

The chipmunk is an interesting little animal for study in some sections of central and northern Alberta. It may be regarded as a typical ground squirrel and lacks the bushy tail of its cousin, the red squirrel, which spends most of its time in the trees. The long

stripes on the back of the chipmunk harmonize to such an extent with the grass and soil that it is often hard to distinguish the animal while it remains quiet. The chipmunk makes a burrow in dry elevated lands. The cheek pouches are apparently used to carry away all the soil removed in the construction of its den, as one never finds a heap of soil near the entrance. The cheek pouches are also used in carrying grain, seeds and nuts to the den. The chipmunk usually disappears when cold weather sets in in November, and is not seen again until April. During its sojourn in its den it depends upon the food which it stored up in the fall. The chipmunk is very easily tamed and soon becomes quite a pet, provided that the household does not boast a cat. Cats and weasels seem to lose no opportunity to destroy this timid little animal. The chipmunk is readily distinguished from the striped ground squirrel (often called the Minnesota or striped gopher) by its shorter body, which is ordinarily not more than half the length of its near relative.

PORCUPINE.

The porcupine, like the skunk, is rather a stupid animal, which depends upon one weapon to defend it from its enemies. The upper part of the body and the wide tail are covered with sharp quills. When the animal is frightened or attacked it humps its body so that the quills on the back act as a shield. It also uses its tail as a club and the luckless person or animal that the tail strikes finds a number of quills left in its flesh. The porcupine cannot throw its quills, as many people believe. The animal is slow and awkward in its movement and does not deliberately attack any living creature. Its large, sharp teeth might well be used as a weapon, but they are reserved for gnawing the twigs and bark off trees. During the winter months one finds trunks of evergreen trees stripped of bark by the hungry animal. It also causes annoyance around the trappers' cabins by gnawing the handles of axes, tools, pails, etc. The animal is a splendid climber and spends much of its time in the trees. The porcupine lives in dens which may be simply holes in decaying trees or large crevices in rocks. The quills which fall out from time to time are replaced by others, which grow in slowly.

BUFFALO.

The buffalo is of particular interest to use in Alberta, because we can boast within our boundaries the largest herd of the animal in captivity—the herd of several thousand animals in the great wired enclosure at Wainwright (about 160 square miles)—and also the only known herd of wild buffalo—the wood buffalo which range within Hay and Slave Rivers along the northern boundary of the province and the neighboring district of Mackenzie. The children of this grade will probably be interested in the story of the great herds of buffalo which at one time roamed the plains, but were ruthlessly slaughtered by Indians and white people alike. The extent to which the Indian of the plains depended upon the buffalo to supply his needs should be emphasized. One author (Mabel Osgood Wright) thus summarises it: "The hairy skin made warm robes and other garments, the hairless hides furnished tent coverings, bags for carrying food, and later, when horses came, saddles, also boats, shields, raw hide ropes, etc. The sinews made the thread to sew the robes, the lattice for snowshoes and strings for bows; from the bones were fashioned many articles for use and ornament; the hoofs and horns gave drinking cups and spoons, as well as the glue with which the Indian fastened his stone arrow heads to their wooden shafts. Part of the meat was eaten fresh, the rest was dried in various ways and kept for further use. The tongues were smoked and dried, the marrow from the bones packed away in skins, while the titbits were pounded fine, mixed with melted fat and sometimes berries also, to make a sort of hash, more nearly like sausage meat than anything else, which was called **pemmican.**"

The great herds of buffalo made their way day after day from their grazing grounds to the nearest body of water, where they not only drank their fill, but also wallowed in the mud. The drying of the mud on their hair protected them to some extent from insects. The herds were known to migrate several hundred miles each year. That the migration was not simply due to cold weather is shown by the fact that the winter range of one immense herd was in central Saskatchewan, about 700 miles north of a point where it was found during the summer. The buffalo were able to withstand blizzards to a much greater extent than our domestic cattle. They were also able to protect the young calves from their arch enemy, the coyote. Great numbers of the animals were drowned in the spring when they attempted to cross the rivers on the thin ice. A favorite method of destruction of the animal by the Indians was to "stampede" a herd over high cliffs along the river banks. The white man is finally attempting to atone for the wrongs of the past, and is protecting the small remnant of the great herds that formerly roamed the plains. Sixteen hundred animals were transferred this year from the Wainwright Buffalo Park to a point along the Slave River, south of Fitzgerald. The grazing ground of the 800 wild wood buffalo in that district has been set aside by the Canadian Government as an immense buffalo reserve. Every lover of wild animal life sincerely hopes that the monarch of the plains may thrive as readily on this reserve as it has done in the comparatively small enclosure at Wainwright.

PROTECTION OF WILD BIRDS IN ALBERTA.

The usefulness of wild birds to man is discussed in Chapter IV, an dthe adaptations of several members of the feathered tribe are deal with in Chapter V.

The Government of Alberta, acting through the Chief Game Guardian of the province, has placed certain restrictions upon the destruction of birds. These "game laws" are outlined in Chapter IV. The Dominion Government has recently adopted the practice of setting aside areas of swampy lands, lakes, and river shore as "bird sanctuaries," where the birds are protected throughout the year. The bird sanctuaries that have been established in this way in our province are at Many Islands Lake, Buffalo Lake, Ministik Lake, Miquelon Lake, Lac la Biche, Birch Lake, Pakowki Lake, Red Deer and Rideau Island in the Elbow River at Calgary. The last bird sanctuary mentioned is of particular interest to children, as it is under the care of the Boy Scouts, who have set out many nesting boxes for the small birds. The number of birds found in these protected areas as compared with other points is ample proof of the appreciation shown by the bird world towards its benefactors. Mammals as well as birds are protected in Banff National Park, Jasper Park, Waterton Lakes Park, Wainwright Buffalo Park, Elk Island Park near Lamont, and the Nemiskam and Wawaskesy Antelope Reserves in the south.

IDENTIFICATION AND INTERESTING FACTS ABOUT WILD BIRDS OF ALBERTA

The identification of many of the common birds of the province and some interesting facts about them are given at this point for reference purposes. Some common birds, such as the meadow lark, robin, blue bird, flicker, "snowbirds," etc., have been treated in previous chapters. The teacher will naturally choose for study the birds found in the school district.

PRAIRIE CHICKEN.

This name is popularly applied in Alberta to two birds, the **sharp tailed grouse and pinnated grouse.** The two birds resemble each other in general appearance and habits, and it is unnecessary to differentiate the two in Nature Study in the schools. The narrow

tail of the birds enables a person to distinguish it from the ruffed grouse (partridge of the north), while its large size distinguishes it from the imported European grey or Hungarian partridge (the partridge of the southern part of the province). The nest, like that of all scratching birds, is on the ground. The young birds, like the domestic chickens, are thickly covered with down and leave the nest soon after they are hatched. Then can fly very rapidly for a short distance, the quick strokes of the wings making a whirring sound. The prairie chicken lives largely upon weed seeds, leaves, berries and grain. The following analysis of the contents of a crop of a prairie chicken which was killed near Edmonton will give one an idea of the quantity of food eaten: 1,866 wild buckwheat seeds; 148 berries; 148 rose leaves; 14 moss leaves; 58 juniper berries; 1 ant; 1 mosquito. A bird which had flown from a wheat field when the grain was all stacked and killed itself by striking against telephone wires had the following material in its crop: 1 fly; 2 lady bugs; 320 grains of wheat; 1,028 wild buckwheat seeds; 233 mustard seeds; 36 leaves of shepherd's purse; 218 miscellaneous leaves.

HUNGARIAN OR EUROPEAN GREY PARTRIDGE.

This bird was introduced into the southern part of the province from Europe several years ago through the efforts of a group of sportsmen. It has thrived to such an extent that it is now found to a limited extent even north of Edmonton. The bird is easily distinguished by its size, as it is much smaller than either the paririe chicken or the ruffed grouse. It is a great destroyer of wild seeds and insects, and as it invariably feeds on the ground any grain eaten is that which would otherwise be wasted. The claim is made in some sections of the province that this bird is driving the prairie chicken away. The author believes that the disappearance of the prairie chicken, coinciding with the great increase in numbers of the European grey partridge, may be easily explained. The prairie chicken is an easy mark for even an amateur with a gun, and is destroyed in great numbers. The European grey partridge, owing not only to its smaller size,but also its greater speed, is not being destroyed on nearly as large a scale. A second factor is the number of young in a brood. There are rarely more than a dozen eggs in the nest of a prairie chicken, while 20 to 24 eggs is not a rare occurrence in the nest of the European grey partridge. The writer believes that the difficulty of killing the partridge, and its more rapid natural increase are the real explanation in the majority of cases.

RUFFED GROUSE.

This is the so-called partridge of the northern part of the province. It is a bird of the parklands and heavily wooded districts rather than of the prairie. It may be easily distinguished from the prairie chicken and European grey partridge by the wider fan-shaped tail and the black or brown ruffs on the shoulders. The female bird gives a warning cry to the young upon the approach of danger, and the chicks squat flat upon the ground in the leaves, where it is hard to distinguish them from the leaves or ground. The mother bird feigns to be wounded, fluttering along on the ground to lead the intruder away from the young birds. When she has persuaded the intrduer to follow her for some distance, she puts to flight quickly. The ruffed grouse puts on "snowshoes" for the winter, that is, small, horny appendages grow out from the sides of the toes in the fall and thus enable the bird to walk more easily on the snow. In the spring these appendages drop off. In very cold weather the bird seeks refuge in the snow banks or allows the snow to drift over it. If the snow becomes crusted at the surface the grouse is often unable to break thrugh the crust, and is thus often destroyed. The bird often spends considerable time in winter perched on trees, where it feeds on the buds. Ordinarily it feeds

on berries and fruits in general, insects and leaves. The "drumming" sound made by the male bird in the spring and autumn is very characteristic of the ruffed grouse. The sound is made by the rapid beating of the wings while standing on a log or stump.

PTARMIGAN.

In central and northern Alberta these birds are winter visitants. The ptarmigan is a scratching bird like the grouse and partridge, but is readily recognized in the winter by its white color. One species is entirely white in winter; the other shows a few black tail feathers during this season. The bird comes to us from the far north, where it nests. The form known as the rock ptarmigan is sometimes found nesting in the Alberta Rockies. In spring the white feathers are moulted, and the bird assumes a reddish brown plumage. The feet of the bird are feathered to the toes.

MALLARD DUCK.

This is the commonest and largest of the wild ducks of Alberta. Both male and female show a purple band bordered with white on the wing, which readily serves as a distinguishing feature from the other large ducks. The male bird has a green head with a white ring on the neck. The bird is the ancestor of most of the domestic ducks seen in the province. The nests are often built on elevated ground near a slough, but are also likely to be found in a plowed field, a mile or more from the water. The mother bird usually covers the eggs with feathers before leaving the nest. Many people claim that the nests are built farther from the water in a year that will be rainy than in a dry year. When the birds have been disturbed by the sportsmen they often circle several times about a new landing spot before alighting, apparently on the lookout for concealed enemies. The food consists largely of water plant animal life. They destroy grasshoppers and beetles, and in the fall months devour great quantities of grain. The flesh of the duck is very palatable where it has fed upon grain.

BUFFLEHEAD DUCKS

This little duck is popularly known as the "butter ball" because the feathers on the cheeks are lengthened, making puffs on the sides of the face. This feature and the fact that the male bird has a black head with a triangular white patch near the eye, serve to distinguish it from the teals, the only other ducks about the same size. The bufflehead is the best diver among the ducks, and usually escapes in this way rather than by taking to wing. It usually builds its nest in a stump or hollow tree. Small fish form part of its food, being caught by diving.

BLUE AND GREEN WING TEAL DUCKS

These are the smallest of the ducks of the province. The former shows a chalky blue color on the wing about a green band, while the latter lacks the blue coloring on the wing. The flesh of these birds is of a delicate flavor in Alberta because its food consists largely of plants. In British Columbia the birds often live upon the dead salmon found in the rivers, giving the flesh of the bird a "fishy" flavor. The teals usually drop down suddenly among the weeds rather than hover over a spot for a time like the mallards. They spring from the water quickly and are extremely rapid flyers.

CANADA GOOSE

The person who coined the expression "silly as a goose" certainly knew nothing of the habits of the Canada Goose. This wild "grey" goose is easily recognized not only by its size but also by the white throat and cheek patches and black head and neck. The nests are built on the ground, but in a few instances under observation in the province the bird has used a deserted hawk's nest high up in

the tree. How the young goslings reach the ground in these instances is a mystery. Nests of the bird are from time to time reported near the rivers and sloughs in nearly all parts of the province. The honking sound made by the birds during migration is familiar to most people. During migration the larger flocks of birds travel in a V-shaped formation, with an old gander as a leader. From time to time a bird farther back moves up and takes the place of the leader. When the birds are feeding in the grain fields (usually in the evening), one or more birds act as sentinels to warn the others of the approach of anyone. Wounded geese or young birds are often introduced into the poultry yard. If their wings are clipped once or twice at the time of the migration of the geese north or south, these other birds soon lose any desire to again join their fellows. These "tamed" geese are sometimes used as decoys, their call causing the wild geese on wing to alight on the slough. The work of Mr. Jack Miner at a point on the Canadian shores of Lake Erie, where birds cross during their migration, should be known to every Canadian boy and girl. By placing corn along the shores of a small lake on his farm and protecting the geese, several thousand now spend a few days or weeks on the farm of their benefactor.

HORNED GREBE

The grebes are often called "hell divers" because they dive at the flash of a gun. They differ from the ducks in having pointed beaks, in having lobes on the toes instead of being totally webbed, and in having the feet placed very far back on the body. This position of the feet and the extreme shortness of the tail are characteristic of the true diving birds. While it enables them to dive quickly it makes the body so ill-balanced on land that the grebe rarely ventures far from water. The nest is built either on a floating mass of vegetation or directly along the water's edge so that the female may dive directly into the water if attacked. The silvery sheen of the breast feathers of the grebes has made them in great demand for millinery purposes. Their food consists of small fish and other forms of water animal life which are captured by diving. The horned grebe is about the size of a flicker and has prominent ear tufts of an ochre color. Hence the term, "horned," is applied to the species. The grebes have the power of changing their specific gravity and slowly sinking into the water until only the bill is above the surface.

SPARROW HAWK

The sparrow hawk, a bird only slightly larger than a robin, is not only the smallest hawk but also the most beautiful species. It may be distinguished from the sharp shinned hawk, the only bird with which it is likely to be confused, by the chestnut coloring on the back and tail of both the male and female, and the black markings on the head of the male. The name, sparrow hawk, is a misnomer, as the bird does not kill small birds to any extent. The nest is usually the abandoned nest of a flicker or other woodpecker or is built in a hollow in a tree. The bird should be protected at all times as not only does it not destroy poultry but it acts as a friend of man in its destruction of grasshoppers and other insects which are its chief food. It is a bird of the open, often perching on a telephone pole or the top of a tree. It flies comparatively slowly and may be often seen capturing grasshoppers, either in the air or on the ground and then returning to its perching place to devour its victim. Unfortunately, the bird is frequently mistaken for the sharp shinned hawk and destroyed on account of the evil work of the latter. The sharp shinned hawk should be destroyed on sight, as it attacks young chickens and many small birds. In addition to the difference in color between the two species, the sharp shinned hawk differs from man's ally in building a nest of sticks and other material in the branches of a tree. It flies by taking a series of rapid wing strokes and then sailing on for a distance. Both birds migrate south in the fall.

SNOWY OWL.

During the winter months these large birds come to us from the districts farther north. They are readily recognized by the fact that they are the only owls which have white as the predominant color of the feathers. Some of the birds are pure white, but the ones usually seen are white with blackish brown barring. In the far north the bird lives upon rabbits, ptarmigan, and other similar forms of animal life. While with us in the winter it seems to hunt almost entirely by day and prefers open country. Its white color makes it inconspicuous when there is snow on the ground. It often perches on straw stacks waiting for a luckless prairie chicken to come forth in search of food. Its destruction of this game bird whilst in our midst is to some extent compensated by the killing of rabbits and mice. The smaller owls which are often found around farm buildings are excellent mice killers.

FRANKLIN'S GULL.

When the farmer is cultivating the land in the spring he often finds that he is followed by a number of birds slightly larger than a pigeon that greedily devour any insects which he unearths for their benefit. These graceful birds are a species of gull named after the ill-fated explorer of northern Canada, Sir John Franklin. The under part of the body is white, the back has a mantle of grey, the head is black, the bill reddish in color, and the white wings are tipped with black. Owing to their destruction of all types of ground insects the birds are of great value to man. They do not eat any grain, but at times eat the eggs of other birds. The bird rarely remains any length of time at one point. One minute it may be swimming in a slough, and the next instant dart off to a neighboring field. In the spring the birds are often found in large numbers on a slough. Here they build a nest of old reeds, with the lower part of the nest often resting in the water. Two or three chocolate eggs often speckled with black, are laid on this platform. The birds usually go south in the latter part of August or early in September to the Gulf of Mexico or South America, where insect life is available.

BITTERN.

Often when one is near a slough one hears a booming sound resembling the driving of a stake in mud. This is the characteristic note of the bittern, often called the **marsh hen** or the **stake driver** or the **thunder pump.** It is a bird that is often heard but seldom seen by any others than observant persons. The bitterns are typical waders, like the herons and cranes, and have the characteristic long legs, widespread toes and long pointed beaks. The tawny color is the easiest mark of identification of the bird other than its note. Two forms of bittern are found, the larger one, the American bittern, being over two feet long, and the smaller species, the least bittern, but half this length. The color blends perfectly with the vegetation along the edge of the slough. If one approaches a point where the bird is it immediately "freezes," keeping the beak pointing almost vertically upwards. It ordinarily will not be put to flight until one is within a few feet of it. If, however, a person unknowingly comes close to the nest the bird may fly directly at one and strike with its pointed beak. The bittern eats frogs and all forms of water animal life which are available along the edge of sloughs. The nest is built on the ground near the water.

KILLDEER.

This little bird with a body but little larger than that of a sparrow derives its name from the note—kildee, kildee, dee, dee, dee. It is a typical shore bird and may be recognized among the other small shore haunting birds by having two dark bands on the breast. It often nests in ploughed fields, and runs about from one point to another, capturing young grasshoppers, beetles, and other noxious

insects. The young birds soon make their way to the water's edge. If one approaches the nest the distress of the parent birds is quite evident. They fly about the intruder with mournful cries, and in some cases imitate the ruffed grouse by feigning lameness. This friendly little bird should be protected, because its food is largely insectiverous.

COWBIRD.

This bird is frequently seen among the herds of cattle. It is the smallest of the dark colored birds or "blackbirds," and is only slightly larger than a sparrow. The head, neck, and breast of the male are coffee colored, and the rest of the body is glossy black. His mate is dark brownish grey in color. In some districts the bird is known as the buffalo bird, a survival of the time when the early settlers saw the birds at home among the buffalo herds, destroying the insects which gathered about the animals. The food consists largely of weed seeds, fruit and harmful insects. The cowbird has an unenviable reputation in the feathered world, because it does not build a nest, neither does it incubate the eggs nor care for the young birds. The eggs are laid in the nest of small birds, such as the sparrows and warblers, in the absence of the rightful occupants. The young cowbirds usually hatch out before the young of the proper occupants break through the shell. They procure the lion's share of the food brought to the nest of the foster parent, and the usual consequence is that the other young birds are pushed out of the nest and perish. The female yellow warbler often outwits the cowbird by building a new nest over the foreign egg.

RED-WINGED BLACKBIRD.

The male of this species of blackbird shows a touch of red on the shoulders, which sometimes appears as an orange color. The female would be classified as a sparrow by the unobservant, as it is streaked brown in color. The bird's favorite haunt is in the rushes and tall grass near the sloughs. Here it builds its nest in the reeds and willows, and takes considerable pains to tie the reeds together to form the foundation of its nest. The light blue eggs are thus laid in a platform which usually overhangs the water. It eats large numbers of weed seeds and injurious insects during the spring and early summer. Later the birds gather in large flocks before going south, at which season they take their toll of the grain in the harvest field.

GOLDFINCH.

The goldfinch is also known as the wild canary and the thistle bird. The male bird has a yellow body with a black cap, tail and wings. Its mate does not display these striking colors. The birds are of a merry disposition, and may be seen perched upon the wild or cultivated sunflower, dandelion, and thistle, as they are particularly fond of the seeds of these plants. They often postpone the building of the nest until late in July or early in August, when the first thistles are ripening. The thistle down is used to line the nests. The birds are often seen in flocks of ten or more in June or July. The flight of the bird is in graceful curves, and on the down path of the wave the male bird sings "per-chick-or-ree." Some of the other notes resemble those of the tame canaries. The male goldfinch is one of the few birds that brings food to his mate while she is incubating the eggs.

KINGBIRD.

This small black and white bird may be called the boxer or pugilist among the birds. It has a concealed orange crest which shows only when the bird is excited. If a pair of kingbirds build their nest in the neighborhood, the other small birds need have little fear of hawks or crows. The moment any bird comes near the nest

the kingbird flies directly at it, and no matter how large the hawk it is forced to beat a hasty retreat. The kingbird, like a skilful boxer, strikes its opponent, but never permits the latter to give a return blow. It will fly just above the back of a hawk, give a furious peck at the back of the larger bird, and by its rapid movements elude the larger rival. In some cases the kingbird will persist in its attack until it has driven the intruder nearly a mile from the nest. The bird captures many insects on the wing.

PRAIRIE HORNED LARK.

The prairie horned lark is a bird about the same size as the sparrow, but may be distinguished from the sparrows by its whitish or pale yellowish throat, combined with the tuft of elongated feathers o neither side of the head. It also has a black patch on the breast and below the eyes. The prairie horned lark was originally found only on the plains, but with the clearing of the forests by the white man the bird has extended its range to Eastern Canada. It is a ground bird which never perches on trees. In some years the bird comes back to the province early in March. In other years large flocks seem to remain with us throughout the winter, although it is probable that these winter birds are another species of horned lark which nests in the far north. If a person is walking along a path on which the lark has alighted it runs along the path before him. In low flight it usually gives a whistling sound. Its melodious song is poured forth as it rises to great heights in the air, and in some instances while the bird is sitting on a small stone in early spring. The nest is merely a depression in the ground of such a depth that when the bird is nesting its back is level with the surface of the ground. The birds destroy great numbers of weed seeds, and deserve the protection of man.

COOT.

The coot, popularly known as the mud hen, is a familiar sight on most of the sloughs in the province. It is easily distinguished from the ducks by the short whitish pointed bill, the dark slate color and the lobed instead of fully webbed toes. The sportsman who shoots the coot believing it to be a duck finds the flesh of very poor quality. The bird swims with a bobbing motion of the head and neck. When put to flight it often flies so close to the water that the feet leave a wake in the water similar to that produced by a stick drawn gently across the surface of the water. The nests are usually built in the reeds along the water's edge.

CEDAR WAXWING.

These beautiful birds are easily recognized at close range by the red sealing wax-like tips of the wings and the yellow band on the tail. While at a distance the crest on the head is conspicuous. The bird is only likely to be confused with its larger cousin, the Bohemian waxwing, a bird of the far north which sometimes comes to us for a few days at a time in late fall or w inter. The cedar waxwing, like goldfinch, does not build its nest when it returns to us in the spring, but postpones this undertaking until July or early August. Before the period of nest building arrives they are often seen in small flocks. The nest is usually built in a coniferous tree. The female bird soon becomes accustomed to prying eyes, and permits close observation of the young birds if no attempt is made to touch them. For several years the waxwings have nested in low evergreens on the grounds of the University of Alberta, where they have been under observation by the teachers at the Summer School. The characteristic note of the bird is a short wheezing sound which is remembered by anyone who once hears it. The waxwing is a typical fruit eater, living largely upon saskatoon berries and other wild fruit. It also is of some value as an insect eater.

PINE GROSBEAK.

The pine grosbeak is usually a winter visitant in the settled districts of Alberta, as it rarely nests as far south as the densely populated part of the province. It may often be seen in flocks during the winter, eating the seeds and fruit of wild plants and trees. The grosbeaks are heavily built birds, with short, thick beaks adapted for crushing seeds. The male of the pine grosbeak is easily distinguished by its general reddish color from the male of the evening grosbeak, which has a yellow color with black wings, tail and crown. The female pine grosbeak is a rusty yellow color. In the north, where it nests in coniferous trees, the pine grosbeak often destroys the buds of many trees. Many of the reports of robins being seen in Alberta during the winter are due to people mistaking the pine grosbeak for robins.

SONG SPARROW.

The song sparrow is the first of our song birds to return to us in the spring. In March before the meadow lark and robin have returned to brighten us with their song, we may hear the cheery notes of this little bird. Looking for the bird from which the notes are pouring forth we are likely to see it perched on the top of a low plant or on slightly elevated ground or sometimes on a telephone wire. It is distinguished from the other sparrows by the two black streaks on the breast, which form a black spot in front that may be seen at some distance. The birds are found in great numbers, and in addition to performing the good function of most sparrows of destroying weed seeds, they also eat many noxious insects. The nest is built on the ground, rarely in low shrubs, and is constructed of leaves, bark and roots with a soft lining of fine grass. The family cat is the worst enemy of the song sparrow, as it captures the nestlings quite easily.

CANADA JAY.

The lumbermen, trappers and settlers in the wooded regions of the province have given several names, such as the whiskey jack, camp robber and moose bird to this permanent resident. The loose, soft grey plumage and the large black capped head serve to identify the bird. Where one is camping in the woods in the northern part of the province and hears strange shrieks or wails which one does not recognize as issuing from other birds, one is fairly well justified in assuming that they proceed from the Canada Jay. The bird is well known around lumber camps, where it comes in search of food. It becomes very bold, and often enters the cook tent to pilfer food, if the occupants do not provide it with food. Moose hunters also usually find it on the scene when they have killed any animals. The most remarkable feature about the bird is that it lays and incubates the eggs in February or March when the thermometer is often many degrees below zero. The nest is usually built of coarse bark and twigs in coniferous trees, and is often lined with the hair of moose and other animals. Why the eggs do not freeze remains an unsolved mystery, although some of the lumbermen claim that if the female leaves the nest her place is immediately taken by the male bird.

MIGRATION OF BIRDS

This always proves an interesting topic for the children. For the lower grades some teachers draw upon the blackboard or large sheet of paper the outline of a tree with many branches. As the pupils report seeing a particular bird back in the district the child's name is placed on a branch with the name of the bird, the date seen, and where seen. Other teachers keep a bird record sheet or book, which is ruled into columns and the same data recorded. Where these records are kept year after year many interesting points about the movements of our feathered friends are discovered.

From the standpoint of migration we may divide the birds of any district into four distinct groups. The members of these four groups will vary in different sections of Alberta. We may call the first group **permanent residents**, birds which not only nest here, but stay here throughout the entire year. To this group belong the English sparrow, chickadee, prairie chicken, ruffed grouse, European grey partridge, and in many districts, crows, magpies. Wherever the great horned owl, Canada Jay, barn owl and the large pileated woodpecker are found they usually remain throughout the year. In some districts where a portion of a river or creek is kept free of ice during the winter the ducks stay throughout the year.

A second group may be called **winter residents.** These birds nest north of us, but visit us for a time in the winter. The pine grosbeak, snowy owl, and ptarmigan are winter residents in many districts. Flocks of snow buntings (snow birds) visit most districts every winter. The other snow bird, the slate colored junco, is a winter resident in some districts, but in other sections of the province is found throughout the year. Another winter visitor is the redpoll, a bird about the same size as the sparrow, which has a red cap on the head, and in the case of the male has a pink breast. The evening grosbeak (see pine grosbeak) is also a winter resident in some localities. The goshawk, the fairly large hawk which is an unwelcome visitor to the poultry yard, is a winter resident in some years, spending the summer in the north, where it lives upon rabbits, ptarmigan, and other wild animal life.

The summer residents—birds which nest in the district, but spend the winter in milder climates, constitute the largest group. To this group belong the robin, meadow lark, bluebird, sparrow hawk, flicker, goldfinch, many of the sparrows, warblers, flycatchers, swallows, kingbird, and countless other varieties of feathered folk. In some districts where there are large sloughs or lakes the ducks are summer residents. Practically all the shore and wading birds come under this head.

Transients or **visitors** would be placed in a fourth group. These birds remain with us for a short time during their migration north to their nesting grounds, or when going south to their winter range. In this group we would place the ducks, geese and golden plover for some districts. Birds which wander from one point to another in flocks, irrespective of nesting period, would also come under this classification. The Bohemian waxwing is a good example.

WHERE DO THE BIRDS GO?

As a general rule insect eating birds travel much farther than seed eaters. The kingbird, the flycatchers, hummingbirds, warblers, golden plover, nighthawk, and most of the swallows travel to South America. Robins, flickers, red-winged blackbirds, and meadow larks usually travel only a few hundred miles south into the United States, while those of these species found in the Central States in summer go to the Southern States in winter. (This was proved by branding birds with tags). Loons and some grebes migrate through the passes in the Rocky Mountains, and winter along the Pacific Coast. Many ducks and geese winter along the eastern coast of the United States.

ROUTES OF MIGRATION.

The majority of birds which winter in South America fly across the Gulf of Mexico instead of following the overland route, despite the fact that they are largely land birds. Another remarkable feature about these birds is that only one-sixth of the species making this trip make the West Indies a stopping point. Many birds follow river valleys in migration, apparently because of the ease of obtaining food en route rather than using the valleys as a guide. The most remarkable flight taken by a bird which is seen in Alberta is that of the golden plover. This bird nests along the shores of the Arctic Ocean and flies to Labrador, Newfoundland, and Nova

Scotia in August. Here it feeds on the crow berry until it becomes quite fat. Thence it flies over the Atlantic Ocean, directly to the north coast of South America, never stopping at the Bermuda Islands unless during a storm. It winters in southwestern Brazil and Argentina. On the return journey north the birds fly through Central America, Mexico, the Mississippi Valley and across Saskatchewan and Alberta to their nesting grounds. They are seen around the sloughs in Alberta for a few days in the spring.

An excellent way to fix the winter quarters and migration routes in the minds of Grade VI pupils is to have them trace an outline map of North America and the northern part of South America. Then have them mark on it at the proper point the names of common birds (e.g., swallow would be shown in Amazon basin), and show by arrows the routes followed by many of the birds. The snowy owl, ptarmigan, etc., would be shown in Alberta on such a map, as would the permanent residents of our province.

PREPARATION AND METHOD OF MIGRATION.

As a preparation for migration some birds, such as the male bobolink, molt their conspicuously colored feathers and don a more sombre attire, apparently as protection for the trip. Others, like the red-winged blackbird, swallows, ducks and geese, gather in large flocks. A few like the golden plover put on flesh to supply energy for a long trip. Birds which migrate exclusively or chiefly by day are either birds which feed habitually on the wing (swallows) or birds which are strong, easy flyers and rely solely on their wings for escape from danger (geese, hummingbird, red-winged blackbird, crow hawk, etc.). Ducks migrate both by day and night. Grebes which depend upon their diving powers for safety migrate by night, as do bittern, snipe, coot, etc. Water birds, such as ducks, geese, loons, etc., do not usually migrate south until forced to do so by the freezing of streams and sloughs. Their return north is governed largely by the time lakes and rivers are free of ice. Many land birds, such as the robin, return north at practically the same time each year, irrespective of the climatic conditions which may prevail.

WHY BIRDS MIGRATE.

Much undue sympathy is wasted by teachers and pupils alike upon the fate that many of the birds would meet if they remained here in the winter. There is little evidence to show that birds go south because their instinct teaches them that they will suffer directly from the effects of cold weather. The English sparrow which remains with us in the winter has no protection against severe weather not found on the song sparrow which migrates. Neither is the chickadee, a permanent resident, better equipped to spend the winter here than is the robin. Many will recall the blizzard in May in Alberta a few years ago. Although the robins had returned nearly a month before the blizzard they seemed to suffer no ill effects from the storm.

The effect of the low temperature upon the food supply seems to be the chief reason that we can give for the birds going south. Birds which will not change their food habits to adapt themselves to conditions in cold weather migrate. The reason commonly given for the return of the birds north is that they come back to nest. Each species has certain latitudes within it nests, and instinct prompts its return there at the nesting period. Thus the golden plover nests within the Arctic Circle. The loon prefers our northern lakes and rivers, etc. This is not to be interpreted that a pair of robins which nest in one district one year will return to the identical spot the following year. Bird banding has shown that certain members of some species do use the same nesting sites year after year.

Valuable and destructive insects are treated in detail in Chapter IV. The identification and life histories of common moths and

butterflies are discussed in Chapter II.

FISHING.

The adaptations of the fish are given in Chapter V. The methods of capturing fish will prove an interesting topic for a lesson. We may deal first with the use of a line with a baited hook, such as is used by many of the small boys in Alberta. The use of artificial "flies," made of showy hair, fur, wool, and feathers in trout fishing may then be studied. The boys will no doubt be glad to bring hooks with these "flies" to show to the class. Next we may deal with the capturing of white fish in some of the lakes of Alberta by the use of nets. In winter holes are made in the ice and the nets placed beneath the ice.

Next we may consider the methods of catching cod, halibut, salmon and other fish which are brought to our stores from other parts of Canada. In the case of cod and halibut the men often fish from small boats, using a hand-line which carries two large hooks baited with small fish. The commonest method is by the use of a trawl line. This is a line about half a mile long, to which are attached at intervals of three feet smaller lines about three feet long, fitted with hooks baited with small fish. As the hooks are baited the line is coiled in a tub about half the size of a flour barrel. At each end of the trawl line are placed an anchor to hold it in position, and a cask to show the fishermen where the ends of the line are. After the trawl line has remained in position for a few hours, the men take up one end of the trawl, pass the boat along under it, remove the fish, and let the line down in the water again after rebaiting the hooks.

Herring are caught in "weirs," which are sticks and brush arranged in the form of a corral a short distance from the shore. The fish are carried into the weirs by the water at high tide, the entrance is closed and the fish caught when the tide goes out. Salmon are caught in different ways in the rivers in British Columbia. In some cases the Indians wade out into the water and spear the fish; at other points nets are extended part way across a river; others are captured in a revolving water wheel which has wicker baskets attached to it.

CHAPTER IV.

GRADE V.

WILD PLANTS IN ENVIRONMENT.

If the school is situated near a slough or lake you will probably be able to obtain specimens of pondweeds and cat-tails for study. The pondweeds live entirely below the surface of the water until the plants are in flower. One of the best known pondweeds is popularly called eel grass. However, it is not necessary to give any other name than pondweed to the plant used in this grade. If possible the children should see the plant growing in the slough. The following points may be discussed: (1) The chief use of the root is to anchor the plant and prevent it from coming to the surface. If the plant does become loosened from the soil at the bottom of the slough it comes to the surface of the water and soon dies. The roots are not required to absorb much water and mineral matter for the plant, as the whole surface of water plants of this type absorbs these materials. (2) The leaves are very thin, since they need no protection as do the leaves of land plants. The water and dissolved plant food passes through these thin walls. (3) The stem is very soft and pliable, and is held upright by the water. This may easily be demonstrated by carefully removing one of the plants from the water. It immediately collapses, because there is no water to buoy it up. Compare this stem with the rigid stem of land plants. (4) When the plant is ready to blossom the stem grows until it is just above the surface of the water. The tiny greenish-brown cross-shaped folwers are massed in a head at the top of the stem. In many of the sloughs we find plants which have a number of bladder-like projections attached to the root to float the plant. These plants are known as the bladder worts.

The cat-tails are adapted for living in the wet land along the edge of the slough, but not for living under water. The roots consist of a great mass of fibres which are able to gain a foothold in the wet ground. The short leaves near the base of the plant add strength to the plant. Have the pupils notice that the lower part of the leaves clasp the stem, thus supporting it. There is little difference between the flower and seed of the cat-tail, except that the latter is browner in color. The attachments on the seed enable it to be carried not only by the wind, but also to float on the water.

The Russian thistle and the tumbling mustard are good examples of plants adapted to dry, windy regions. The latter is discussed in detail in Chapter V. The small leaves of the Russian thistle which give off little moisture are rather characteristic of plants growing in dry regions. The general spherical shape of the plant exposes comparatively little surface to the action of the sun, and also enables the plant to be carried readily by the wind when the stem becomes brittle and breaks off at the surface of the ground in the fall. The stiff spines of the mature plant protect it from animals to a considerable extent, while the fleshy nature of both stems and leaves permits a certain amount of water to be stored up for use in very dry weather. The different forms of sage brush or sage, as they are popularly called, show another adaptation of dry region plants, namely, the mass of fine hairs covering the leaves and stems. These hairs reflect the light and thus prevent loss of water through the leaves.

If the teacher is in a district near the mountains it may be possible to obtain specimens of plants from a region which is high as well as dry. In general these will have shorter stems, smaller leaves, more strongly developed roots, and usually somewhat more deeply colored flowers than have plants of the same species growing near the foot of the mountains.

Shade loving plants, such as ferns, commonly have much larger leaves than sun loving plants, such as yarrow. Apparently the ferns wish to make the best use possible of the limited sunlight by exposing as much surface as possible for making starch. The large leaves of the fern are not as strongly exposed to the action of the wind as are the narrow leaves of sun loving plants.

Trees and shrubs are discussed in Chapter III. Mushrooms, or as the children probably call them, toadstools, are always the source of much interest to the pupils. The most striking difference which they will immediately notice between mushrooms and other common plants is the lack of green color in the former. Since the mushrooms have not the green coloring matter present they cannot make food as do the green plants. (See the Plant Factory near the end of this chapter). They obtain their food instead from the decaying plant material in the ground. The children can be given the names of the four parts of the mushroom which appear above the ground, namely, stem, ring, cap (cover) and gills (the rays on under side of the cap). Remove the stem of a mushroom which has just expanded and place the cap gills down on a sheet of white paper for several hours. If the paper is then examined the pupils will notice that it is covered with a fine powder which may be brown, pink, black, yellow, or even white in color. These are the **spores** which take the place of seeds of other plants. The gills thus act as a case for the spores. If there are many mushrooms at any point in the district have the pupils dig up some of the soil and search for fine white cords. These cords are the **spawn** of the mushroom. This spawn often grows for several months in the soil, feeding on the decaying plant matter. On these cords are gradually formed buttons, which are the beginning of the mushroom. The buttons in some cases are no larger than a radish seed, while in other cases we find them the size of marbles. These buttons quickly push their way through the ground, and so rapid is the growth at this point that the mushroom seems to spring up over night. They soon turn dark and decay.

THE WILD ANIMALS IN ENVIRONMENT

The material for all features outlined under this head except that on reptiles has been given in previous chapters of this book.

The common garter or garden snake is a very interesting subject of study for this grade. This harmless, beautiful and useful animal is worthy of study by every pupil in Alberta schools. The lurking fear of this animal, which we are all likely to meet in our walks, should not be a legacy of any child who has ever studied nature. While the fear of snakes may sometimes be hereditary, it is more commonly due to the absurd stories told to children by their elders who display an amazing ignorance of the habits of the animal.

If the boys obtain a live specimen and place it in a glass covered box or in a large glass vessel, the habits may be easily studied. The following points are worthy of note by the pupils: (1) The thrusting out of the red barbed tongue of the snake is not for the purpose of striking a person, but is used to find out about its surroundings in the same way that an insect uses its feelers. Where the author has kept these snakes in captivity and has allowed pupils to handle them freely he has never found the slightest attempt made by the snake to bite anyone. (2) The body is not slimy, as the scales are quite dry. The animal is cold-blooded, which probably accounts for people speaking about the slimy feel of the snake. (3) On the back of the snake the scales are arranged in rows which run lengthwise on the body. The scales protect the skin as the animal glides across rough stones, soil, and brush. On the lower side of the body is a row of overlapping plates running crosswise which connect the ends of the small ribs. Close examination will show that the hind edge of each plate projects down and is thus able to both pull and push itself along. If the snake

is placed on a piece of smooth polished glass it can make little if any progress owing to the scales being unable to get hold of a rough surface. (4) The snake swallows its food both alive and whole. It shows several adaptations which enable it to perform this feat. The teeth point backward and are used to prevent the prey from escaping and not for chewing. A bone acts as a hinge between the upper and lower jaw and allows the jaws to open until they are in practically a vertical position. The lower jaw is in two halves and the victim is slowly drawn in by the alternate pushing forward and drawing backward of the two parts. The body walls are quite elastic, enabling the snake to accommodate the body of the victim. Toads, frogs and birds form the chief food. Birds are usually swallowed head first. After "bolting" its meal, the snake lies inactive for some time as digestion is a slow process. (5) In the fall the snakes seek a sheltered crevice or burrow and hibernate until spring. (6) The skins are shed from time to time in order to permit the growth of the animal. (7) The young of the garter snake are born in July and August. The small brown snakes lay eggs about the size of sparrows' eggs under stones in June and July. The rattlesnake, which is found in the southern part of the province, differs from the other common snakes in having poison fangs in the mouth. The idea often expressed by people that they can tell the age of a rattlesnake by the number of rattles on the tail has little foundation. While it is true that the snake adds a rattle each time it sheds its skin, it often sheds its skin more than once a year. Moreover, some of the rattles gradually wear off the tail.

ANIMAL RELATIONSHIPS

PLANT-EATING MAMMALS

The "chewing of the cud" may be discussed in the case of tne sheep, cow, deer and bison. The animals have a specialized stomach which is really made up of several stomachs. The food is swallowed without chewing and passes into one of the stomachs. It is formed into distinct masses and later, when the animal lies down to rest, these masses are returned to the mouth for thorough mastication. It then passes down the gullet a second time and finally enters the true stomach. The grinding teeth at the back of the mouth are practically all of the same size and are separated from the front teeth by a wide space. The animals have no front teeth in the upper jaw, and the children will often notice that the cow moves the head up and down to aid it in cutting off leaves. The pupils' attention should also be drawn to the fact that the small pointed jaws of the sheep enable them to cut short grass off almost at the roots and thrive where cattle would perish. The antelope of our western plains eats grass and sage but refuses to touch twigs or leaves. On the other hand, the moose and most forms of deer lively largely upon twigs and leaves.

In speaking of the bison (buffalo), reference may be made to the fact that the only herd of wild buffalo known to exist grazes between Hay and Slave rivers along the northern boundary of our province and the adjoining district of Mackenzie. Our province also boasts the only large herd of buffalo in captivity in the Buffalo Park at Wainwright. This herd increased in numbers to such an extent that two years ago over one thousand animals were slaughtered and the meat sold throughout Western Canada. This year the officials have tried the experiment of shipping 1,600 animals from Wainwright to a point on the Slave river, south of Fitzgerald. The animals have been released on a great unfenced reserve that has been the grazing ground of the wild wood buffalo. It will be interesting to follow the results of the experiment.

The mountain goats and mountain sheep often graze at such great heights that there is little, if any, grass available. At these

altitudes they depend largely upon moss for food. The animals are remarkable climbers. The white color of the mountain goat is regarded by some people as protective coloration against the background of snow on the mountain sides.

The gophers, rabbits, muskrat, beaver, mice and squirrels belong to rodents or gnawing animals. The front teeth keep growing continually. The gnawing habit of the animals prevents these teeth from growing too long, while the fact that the front edge of the teeth is harder than the back keeps the teeth sharp. Not only do the gophers destroy the blades of grain and the grain itself but they also store up grain in their burrows to tide them over the period in the spring after hibernation is over and before plants are available.

The food of the muskrat consists largely of roots of plants. The winter home is so arranged that the animal can pass from its den to the water below and obtain the roots below the ice. The beaver is particularly fond of the bark of the poplar and aspen as well as the bark and twigs of hardwood trees. It does not eat any part of coniferous trees, although it cuts them down for building material. During the summer it also eats berries, pond lily roots and other vegetation. Since the beaver does not hibernate, it must make provision for food for the winter. It sinks logs in the mud underneath the lodge and places the smaller twigs in a pile of brushwood at the top of its winter home. After eating the bark from the logs in winter, it uses the logs as an addition to its roof or in a dam. Field mice live largely on grain and seeds in general, but will eat leaves where other food is not available. They store up food in their dens for winter use. The rabbits of the prairie eat grain and nearly everything that is green. In some cases they destroy the bark of low shrubs.

PLANT-EATING INSECTS

CUTWORMS

There are several forms of cutworm in Alberta, the red or pink-back species being one of the commonest forms. The cutworms usually hide in the soil during the day, coming to the surface at night. They cut off the grain and garden plants near the ground or a little below it. Thus it is not simply the amount of foliage eaten by the insects but rather the number of plants cut down that constitutes the chief damage done by these insects. The cutworms are the larvae of rather large drab colored moths or millers which are seen in great numbers in July and August. The eggs are laid on the leaves of grass or weeds in late summer. The small cutworms feed upon grass until cold weather when they seek refuge in rubbish or in the soil. In the spring they attack grain and vegetable crops and are usually full grown towards the latter part of June. They then burrow into the soil and form the brown pupae about one-half inch long which are familiar to everyone who has worked in a garden. The adult moths emerge about two weeks later.

WEEVILS

The term, weevil, is applied to beetles that have long snouts. One of the commonest forms is the great willow weevil, a dull grey insect from one-quarter to one-half inch long. It destroys the leaves and stems of the tree. Other weevils, brown in color and about one-sixth of an inch long, are destructive to flour and stored grain. Flour mills and granaries have to be fumigated in many instances in order to destroy the pest. Dried peas and beans often show round holes which are the work of weevils. The alfalfa plant is often attacked by a dark weevil about three-sixteenths of an inch long which is covered with black and grey hairs. The adults puncture the stems, and the larvae destroy the leaves of the alfalfa. The eating of the edges of clover leaves in regular scallops is often the work of weevils.

FOREST TENT CATERPILLAR

This insect has worked havoc with the trees in the central part of the province during the last two or three years. The adult moths which are light-brownish-yellow in color, are found fluttering around the trees and lights in July. The eggs are laid in a compact ring around the twigs of willow, alder and other trees, and are covered with a protective shiny varnish. The young caterpillars, which appear early in the spring, are dark in color with a row of conspicuous diamond shaped white spots down the middle of the back. The caterpillars attack the leaves of practically any tree other than the evergreens. When full grown in the latter part of June they are about two inches long. Despite its name, the insect does not construct a ten or web as does the tent caterpillar which is a pest in the orchards of Eastern Canada. The caterpillar spins a silken cocoon around itself and remains in the pupa stage about two weeks. Fortunately, large numbers of the pupae never emerge from the cocoon, owing to the work of parasites on the caterpillars. (This topic is treated later in this chapter).

ONION AND CABBAGE ROOT MAGGOTS

The roots of cauliflower, cabbage, turnips and radishes are often found infested with small white grubs about one-quarter of an inch long. These insects are the cabbage root maggot, which injures or destroys the roots by burrowing into them. The adult is a fly, smaller and more slender than the house fly. They may be seen flying close to the ground after the plants are set out, and depositing white eggs on the ground or on the stems of the plants. The green cabbage worm, the larvae of the cabbage white butterfly, is discussed in Chapter II. The onion root maggot, which attacks the bulbs of the onion, is similar in its habits to the cabbage root maggot.

COLORADO POTATO BEETLE

The Colorado potato beetle, popularly known as the potato bug, is doing considerable damage in the southern part of the province. The bright orange eggs are laid on the under side of the leaves of the potato plant soon after the plant appears above the ground. The larvae are "humped-back" creatures, brownish-red in color, which devour the leaves of the potato. In July the larvae work their way down into the ground, where they pass the pupa stage. The adults are about one-quarter of an inch long and are readily recognized by the ten black lines which run lengthwise on the orange or yellow wing covers. The adults usually emerge in August and after feeding on the plants, spend the winter in the ground. Fortunately, large numbers of the adults are destroyed by the winter frosts. It is interesting to note that the Colorado potato beetle originally lived upon wild plants in Colorado. When the early settlers in that state started the growing of potatoes in 1859 the insect changed its food habits, and in 15 years had reached the Atlantic coast of the United States and Canada. Since that time potato growers in the east have spent millions of dollars annually in the purchase of poisons for the spraying of plants.

Several other beetles which attack vegetation have interesting histories. The carragana and many leguminous plants often act as host for large, long beetles. One of the most striking is deep blue in color with shining wings. These beetles are known as blister beetles because the bodies of certain species are ground up into powder and used in the making of "fly plasters." The leaves of the willow, alder, poplar and other trees often show the greenish layer of the leaf removed, leaving only the greyish structure. This is the work of some of the leaf beetles. One of these beetles, the Lapland leaf beetle, is about the same size and shape as many of the lady bird beetles (lady bugs). In the garden or grass one sometimes finds slender brownish-yellow shining worms, half to one inch long. These

are popularly spoken of as wireworms. The insects are destructive to the roots of grass and grain. The adults are the well known click or snapping beetles, so called because when placed on their backs they snap up into the air with a clicking sound in an endeavor to "right" themselves.

APHIDS OR PLANT LICE

Many of our summer wild flowers have the leaves and stems of the plants covered with small plant lice or aphids. They are usually green in color, although a few species show other colors. The eggs, laid on the stems of plants in the fall, hatch out in the spring into wingless females which suck the sap from the leaves and stems and become full grown in two or three weeks. These females have the unusual feature for insects that they give birth to living young. These young plant lice quickly reach maturity and in time give rise to another generation. Whenever the food supply is in danger of running short, a brood of insects having four wings is produced. These fly away to another plant and start a new colony. If the pupils examine the golden rod plant in September they will be able to see both the winged and wingless forms on the plant. The relation of aphids to ants is discussed in Chapter II.

BIRDS IN RELATION TO VEGETATION

We have many birds in our province which are typical seed eaters. The one best known to the children is the common English or house sparrow, which is such a pest in all parts of Alberta. The short, stout beak of the bird is well adapted for obtaining and crushing seeds. In Western Canada the birds do little damage by destruction of grain seeds, confining their efforts largely to weed seeds. In Eastern Canada the birds are found around granaries and mows of the barns, where they destroy considerable seed. The children will be interested to learn that the English sparrow was introduced into New York about 1850, because the people believed that it was an insect eater. While the bird, in common with practically every other species, does destroy a few insects, it can never be classed as a typical insect eater. The objections to the bird will be discussed under pests and nuisances.

The two "snowbirds" of Alberta, the snow bunting and the slate-colored junco (see identification in Chapter I) are other good examples of birds which destroy weed seeds. Two other winter visitors from the north, the redpoll and the pine grosbeak, belong to the same class. Flocks of the redpolls wander about from point to point during the winter doing good service to the farmer by destroying various weed seeds. The birds are smaller than the English sparrow. Both sexes have a dull crimson cap on the head, and the adult males in addition have rosy breasts. The pine grosbeak eats the rose hips and wild fruit left on the branches, as well as the seeds of coniferous trees. It also destroys weed seeds.

The American robin should not be left in the class of fruit eaters as far as Alberta is concerned. While it is true that it eats saskatoon berries, strawberries and other small fruit at time, it is essentially an insect eater. A typical fruit eater for our province is the cedar waxwing, described in Chapter III. This friendly bird captures many insects in the air but the bulk of its food consists of wild berries and fruits.

RELATION OF ANIMALS TO OTHER ANIMALS

FLESH-EATING MAMMALS

The coyote, badger and weasel are discussed in Chapter V. The timber wolf is a much more dangerous animal than its cousin, the coyote. During the summer it is of solitary habits and depends upon small mammals (rabbits, etc.) for food. In winter they hunt in

packs and attack the larger animals. There are cases even in Canada where famished wolves have killed men in the winter. The author knows of a case of a missionary in Northern Ontario who attempted to travel by dog sled from one of the mines to the nearest railway station in the middle of winter. The following spring his bones, those of his dogs, the harness and sleigh were found on the route. There is the possibility in this case, of course, that the man was frozen to death and the dead body was devoured by the wolves. The persons who made the gruesome find believed, however, that the missionary was killed by the animals.

In dealing with the fox the teacher should describe the raising of foxes for their fur. Fox farming is no longer confined to Eastern Canada as there are several flourishing fox ranches in our own province. The flesh of rabbits and old horses is extensively used for food at the fox farms. Considerable care has to be taken that strangers do not disturb the animals. The female foxes in some cases havve been known to destroy the young in the underground den. The cleverness of the fox in outwitting dogs by throwing them off the scent is worthy of mention. "Red Fox" by a Canadian author, Charles Roberts, is an interesting story for children in this grade. The kit fox of the southeastern part of the province is about the size of a large cat. It destroys mice and when snow is on the ground captures prairie chicken. At times it attacks domestic fowl. It is much less suspicious of man than is its larger cousin, the prairie red fox.

The mink is closely related to the weasel. It has webbed feet and is at home both on land and in water. It destroys frogs, fish, muskrat, as well as small land mammals, and at times raids the poultry yard.

In studying the flesh-eating mammals, it is wise to draw to the pupils' attention the way in which they are fitted for their life. Reference should be made to the fact that they have four sharp canine teeth for piercing the flesh. Examination of the mouth of a cat or dog will enable the pupils to see the position of these teeth. Flesh-eaters are usually animals which are very active in their movements; their claws are sharp and strong; their color is usually in harmony with their surroundings.

BIRDS EATING FLESH, FISH OR OTHER BIRDS

The eagles, hawks and owls which attack both mammals and birds, have the upper part of the beak hooked for tearing their food and show the powerful talons for seizing and holding the prey. The larger hawks usually sail around in great circles at considerable heights, but when they have sighted their prey they descend with lightning speed. The smaller hawks, which attack poultry, do not habitually soar to great heights. They depend upon taking their prey by surprise and quick attack rather than by open pursuit. The golden eagle attacks sheep and small calves, and often pursues game birds for considerable distances. The bald eagle eats carrion and fish. In the mountainous districts it may be seen perched on a tree near a lake. When a fish hawk has captured a fish, it is pursued by the bald eagle to considerable heights and forced to drop the fish. The eagle then swoops down rapidly and captures the fish as it is falling through the air.

The owls, with the exception of the snowy owl and hawk owl, hunt almost entirely by night. At night the pupils of the large eyes expand until they cover most of the eye. Its eyes, like those of the cat, are thus fitted for hunting by dark. The food of the majority of the owls consists largely of mice. Wherever possible, the victim is swallowed whole, and later is thrown up through the mouth the pellets of bones, hair and other indigestible parts. The economic status of birds of prey will be discussed under pests and nuisances.

The kingfisher and pelican are good examples of birds that live on fish. The kingfisher perches on a branch overhanging a creek or

river. Suddenly it leaves the branch, remains in position for an instant over the water, then strikes the water with a splash, and returns to its perch with the fish in its strong beak. The fish is usually killed by striking its head against a branch and is then devoured head first and whole. Later, the kingfisher follows the practice of the owl of emitting the indigestible scales and bones from the mouth. Owing to the fact that it eats the fish whole, the kingfisher's diet is restricted to comparatively small fish.

The pelicans are found in large numbers on islands on some of the rivers and lakes of the northern part of the province, and are rather rare in southern Alberta. The most striking features of these great white birds are the long, flattened bill and the great pouch attached to the bill, which often has a capacity of a gallon. The bird obtains the fish by darting the bill into the water as it swims quietly in the shallow water. The fish is then often tossed into the air and is transferred to the pouch, to be eaten later by either the adult or the young birds.

Crows and magpies often act as scavengers in eating the flesh from the bones of many dead mammals. They have a black record for their destruction of both the eggs and nestlings of many beneficial wild birds and if the occasion presents itself will not hesitate to destroy the eggs of poultry as well as kill small chickens.

The kingbird should not be put in this division, as has been done in the course of studies. See description of bird and its habits in Chapter III.

BIRDS EATING INSECTS, INSECT EGGS AND LARVAE

We may divide these birds into groups for study. In the first group we may place the swallows, nighthawk (mosquito hawk), kingbird, sparrow hawk and the fly catchers. These birds capture the insects while in flight. The swallows fly swiftly through the air with their mouths wide open and thus entrap the insects. The nighthawk follows the same plan about dusk. These birds have weak bills, which are of little importance for capturing food. The fly catchers are small birds with rather long and broad bills. They set on a branch of a tree until insects come within a short distance of them and then dash out and capture them in the air. The kingbird follows the same practice. The kingbird and the phoebe really belong to the group of fly catchers. The quick, short note, "phoebe," will identify the latter bird, as will the nest of mud and grass often found attached to buildings or bridges. The sparrow hawk might better be called the grasshopper hawk because of its destruction of these insects.

To a second group belong birds such as the warblers, chickadee, and woodpeckers, which obtain most of their food on trees. The term warblers has been applied to a large group of small birds which have notes that are often not musical, but usually serve to identify the bird. One of the best known warblers is the yellow warbler, often called the summer yellow bird or wild canary. The warblers often destroy not only the insects found on leaves and stems of trees, but are often seen on blades of grass and wild flowering plants in pursuit of food. The chickadee is discussed in Chapter I, and the flicker, the commonest woodpecker of Alberta, in Chapter V. In connection with woodpeckers it may be well to stress the fact that the woodpeckers, with the exception of the yellow bellied sapsucker, do not attack a sound tree. Wherever the birds have made the small openings in the trees it will be found that tree-boring beetles, ants, etc., were at work. In a third group we may place the meadow lark, robin, bluebird, etc., birds which obtain insects from the ground.

BIRDS EATING WATER INSECTS, MINNOWS, TADPOLES AND OTHER FORMS OF WATER ANIMAL LIFE.

The ducks and geese obtain not only animal life from the water,

but also small water plants. The tooth-like projections on the bill serve as a sieve to separate the solid matter from the water when the bird obtains a mouthful of mixed food by putting its head down into the water. Ducks and geese also destroy considerable quantities of grain in the harvest fields in the fall. The grebes and loons, being typical diving birds, are able to capture fish and other forms in their strong pointed beaks by diving for them.

The black tern in Alberta eats comparatively little water animal life while here in the summer. It may often be seen in the fields following the plow or harrow in order to obtain the insects which these implements expose to view. The gulls, which are largely scavengers on the Great Lakes and along the sea coast, also destroy many land insects in our province. The bittern and heron, which are representative wading birds, live largely upon small frogs, tadpoles, and minnows. The snipe (English, greater yellow legs, lesser yellow legs) are shore birds with long, slender, sensitive bills for probing in the mud for minute forms of animal life.

AMPHIBIANS.

Frogs are discussed in Chapter II. The eggs of the toad differ from those of the frog in that they are in long strings rather than in an irregular mass. The development of the tadpole of the toad is similar to that of the frog. The fact that the toads usually leave the water in large numbers on rainy days is probably the origin of the incorrect idea about toads coming down in the rain. The warts on the back of the adult contain a fluid which is repulsive to many enemies of the animal, but are not responsible for people who handle toads acquiring warts on their hands. The toad has the same adaptations for procuring insects as has the frogs. Like the latter, it hibernates. Instead of working its way into the mud of a slough, it burrows into drier ground. The salamander is popular but incorectly called the lizard in Alberta, although it is not a reptile like the true lizards. The salamander, like the frog and toad, spends the first part of its life in water. When it comes on land it still retains its tail. The salamanders must live in damp places, as otherwise the skin will dry and the animal die. Thus they are rarely seen except after a rainstorm. They live upon small insects.

INSECTS LIVING UPON OTHER INSECTS.

This important topic should be included under the relation of animals to other animals. Insects which destroy other insects are either parasites or predaceous insects. The parasites usually develop in the larvae state within the bodies of their victims. Predaceous insects feed upon their victims by either devouring them or by sucking their blood. Good examples of the predaceous insects are: (1) Dragonflies, which in the nymph stage devour the larvae of mosquitoes and other water insects, and in the adult stage destroy the adult mosquitoes and often eat one another. (2) Ladybird beetles (ladybugs), which lay their eggs on plants infested with plant lice. The larvae when they hatch out destroy great numbers of the lice. (3) Ground beetles (often black in color), which eat various caterpillars, such as cutworms. (4) Wasps (many species), which provide the larvae in their nests with flies, grasshoppers, caterpillars, spiders, etc. In many cases the insect has been paralyzed by the sting of the adult wasp and thus rendered helpless.

Among the parasites are the various ichneumon flies. These slender bodied, four-winged insects resemble wasps, and may be seen in every part of the province. They vary in size from about one-eighth of an inch in length to 2 or 3 inches long, and even longer. The female fly pierces the skin of caterpillars (e.g. cabbage worm, forest tent caterpillar), and the young maggot when it hatches out absorbs the body juices of its host. In some cases the caterpillar is able to reach the pupa stage and spin a cocoon before the larvae of the parasite succeeds in destroying it. This has been

true in the case of the forest tent caterpillar in Alberta during the past two years. If the cocoons are broken open the pupa of the moth is found dead, but the maggot of the fly changes into the pupa within the protection of the cocoon formed by its host. In the case of some ichneumon flies the maggots become full grown, burrow through the skin of its host, and form a cocoon on the surface of the body of the caterpillar. Other ichneumon flies lay their eggs in the burrows of tree borers, and the young larvae find their way to their host and suck the substance of its body.

The Tachina flies, two-winged flies resembling the housefly, but usually somewhat larger, are another important group of parasites. They are responsible for the destruction of many cutworms, army worms and other injurious pests.

RELATION OF ANIMALS TO MAN.

Under the grouse would be included the prairie chicken (two species—the sharp tailed and pintailed grouse), the ruffed grouse (the partridge of the northern part of the province), Canada grouse (often called the spruce partridge or fool hen). The only true partridge of Alberta is the imported species, the Hungarian or European grey partridge, popularly called simply the partridge in southern Alberta. Descriptions of these birds are given in the previous chapter. The Hungarian pheasant has also been introduced into the southern part of the province, but has not yet firmly established itself as a game bird. A few pheasants have also made their way from British Columbia into the foothill region in the south. The black bellied plover and golden plover, small shore birds about the size of the killdeer, are the only ones which can be classified as game birds for Alberta.

By seasons is no doubt meant the time of the year when persons are permitted to shoot the game birds. The following is a synopsis of the game laws of the province as they effect the game birds:

Ducks, geese, rails, coots (mud-hen), black bellied plover, golden plover, yellow leg snipe and Wilson (English, Jack) snipe, may be shot from September 15 to December 14, 30 ducks per day, 15 geese per day, but not more than 200 in the season; 25 coots, rails, and Wilson snipe per day, and 15 of the other birds daily. Grouse may be shot in the month of October, 10 per day and 50 in a season. Hungarian partridge may be shot south of the North Saskatchewan River from September 15 to November 14, 15 per day, 75 in the season. There is a close season on game birds not mentioned. The laws relating to the shooting of other birds may also be worthy of note for reference purposes. Crows, eagles, goshawks, pigeon hawks, duck hawks, cooper's hawks, hawk owls, blackbirds, grackles, English sparrows, loons, cormorants, pelicans, and magpies may be destroyed throughtout the year. No other birds may be killed at any time unless by special license for collecting.

FUR-BEARERS.

The muskrat is the most valuable of the fur-bearing animals of Alberta from the standpoint of the value of the pelts taken. Owing to the scarcity of the animal south of the North Saskatchewan River, due not only to extensive trapping, but also to dry seasons, the trapping of the animals in this southern part of the province is now forbidden unless under special permit. In the rest of the province they may be trapped from December 1st to May 1st. The pelt of the muskrat is used for the manufacture of coats and coat linings, and after dressing and dyeing is known as Hudson Seal, one of the most expensive and fashionable furs on the market. In trapping the muskrat the Indians often use an iron rod about 3 feet long set in a long handle and slightly barbed at the tip. This spear is often driven through the home of the muskrat, impaling the

inmates. A hatchet is then used to make a larger opening and obtain the animals.

The skunk, owing to its use of the offensive secretion, has been free from attack so long that it has lost its speed, its ability to climb, and has become stupid. It is easily trapped, but the trappers often have considerable difficulty in handling it before destroying it. It is sometimes trapped in steel traps that have jaws which are opened by compressing a spring, and held in position by a trigger. When the animal steps on the part of the trap connected with the trigger, the latter is released and the jaws close on the leg or other part of the animal, frequently killing it outright. Steel traps are used in trapping many fur-bearing animals. The pursuit of the beaver was really responsible for opening up of a considerable portion of Canada by the white man. There is at present a close season throughout the year on beaver in Alberta. In the early days of the fur trading companies the fur of the beaver was used to a great extent in hats. With the substitution of silk, the fur decreased in value. It has regained its popularity and is extensively used for collars, stoles and muffs. One method of trapping the beaver is by means of a noose fastened to a branch that has been bent down into the water. It is so arranged that when the branch springs up the noose tightens round the animal's neck, raises it from its feet, and eventually strangles it . Steel traps are also used.

The mink is easily trapped, as it is unsuspicious of danger in inanimate form. The traps are often baited with the head and blood of a large bird. A "box trap" is often used for mink, weasel, and other small animals. It is made in the form of a box, one end of which is fastened to the top. The latter is hinged at the rear. This movable section of the box is supported in a raised position by a string attached to a catch. The bait is attached to a spindle connected with the catch. When the bait is disturbed the raised top and end of the box are released and fall, imprisoning the animal.

In the case of timber wolves and coyotes a drag (often a heavy log or stone) is attached to the trap so that the entrapped animal may move a certain distance. If the trap were fixed firmly, the animal in its endeavors to escape might simply leave a leg in the trap . Timber wolves are very suspicious of traps, and fight shy of any metal on the surface of the ground. Some trappers bury a lump of meat and a few feet away place a few traps that have been rubbed with blood, but not touched with the bare hand. The traps are lightly covered with earth. The trapper in this case depends upon the coyote's habit of burying supplies of food. When it is attracted to the buried meat it releases the trigger on one of the steel traps in its attempt to reach the meat.

Some animals are trapped in what are popular called "deadfalls." They consist of heavy logs weighted with stones, which fall upon the animal and hold it fast or crush it to death. Three sticks notched and fitted to form a figure 4, with the bait attached to the horizontal stick, are often used to release the weight of deadfall on the animal.

PESTS AND NUISANCES.

Mammals.—From the work already taken up in this chapter and the details given in Chapter VI, there should be no difficulty in indicating the methods in which the animals listed do injury to man. The skunk is placed on the "blacklist" because of its destruction of the eggs and young birds which nest on the ground. It renders a service to man in its destruction of mice and insects (particularly grasshoppers).

The wolverine (often called the glutton) is one of the worst enemies of the trapper. They follow up the line of marten (Canadian sable) traps and secure the animals instead of leaving them for the trapper. They often move the traps some distance and bury

them in the snow. They also destroy or carry away furs and implements that have been stored by the trapper.

Birds.—The house sparrow referred to under this head is simply another name for the English sparrow. The bird is regarded as a pest because it drives away useful birds, and because of the dirt created about buildings by the untidy nests of grass, straw and strings. While the young sparrows are in the nest they are fed largely upon insects. To provide these nests for the young the adult sparrows compete with other birds which are insectivorous throughout their lives. The sparrows stay here in winter, and in early spring occupy all the most suitable nesting sites before the beneficial birds return from the south. Many species of beneficial birds refuse to nest near the sparrow because of the quarrelsome habits of the latter.

Crows and magpies are classified as nuisances because of their destruction of the eggs and young of many species of small birds. They also at times are guilty of attacking the young chickens. The crows also destroy sprouting grain. On the favorable side of the ledger the bird must be credited with the destruction of a certain number of mice and also given credit for its work as a scavenger in eating the flesh of any dead animals it finds.

From the standpoint of its food habits the cowbird (often called the buffalo bird) should be considered as a useful bird owing to their destruction of weed seeds and injurious insects. The bird is, however, the only parasite among our Alberta birds. (See Chapter III).

In the case of the hawks pains should be taken to correct the idea that all hawks are harmul to man's interests. As an actual matter of fact only five of the sixteen species of hawks in Alberta should be blacklisted. Two of these hawks, the pigeon hawk and duck hawk, are extremely rare, while a third, the goshawk, usually visits us only in the winter when rabbits and other prey are scarce in the far north. The goshawk destroys many prairie chicken and also attacks poultry. The sharp shinned hawk, often confused with the beneficial sparrow hawk (see Chapter III) destroys great numbers of small birds and at times kills small chickens. It should be killed on sight. The same statements apply to a slightly larger hawk, Cooper's hawk. The large hawks, the sparrow hawk and the marsh hawk, should be protected because of their destruction of insects, gophers, field mice and other harmful forms of animal life.

HARMFUL INSECTS.

Under this heading we can deal with insects which carry disease, such as the housefly and mosquito; those which destroy plants, such as grasshoppers, cutworms, forest tent caterpillars, cabbage worms, potato beetle; the ones which destroy trees, such as wood boring ants and beetles; the ones which eat holes in clothing (larvae of clothes moths), and insects which attack animals and man (horse bot-fly, sheep ticks, poultry lice, "bulldog" flies, etc.). The yellow eggs of the bot-flies are laid on the hair of the forelegs. They are transferred to the mouth and later to the stomach when the animal licks itself. The larvae attaches itself to walls of the horse's stomach, where it causes considerable irritation and interferes with digestion. The larvae when full grown pass down the intestines and are excreted. The pupa stage is passed in the soil. In the case of the clothes moth the children's attention should be drawn to the fact that it is the minute caerpillars and not the adult moths which destroy the textiles. The adult moths have sucking mouth parts and are unable to do any direct damage to cloth.

The rattlesnake is dreaded because of its poisonous bite. As far as its food habits are concerned it is one of man's allies in the destruction of gophers, mice, and young rabbits.

WILD FRIENDS TO MAN.

Birds.—The song sparrow, meadow lark, and goldfinch are three of our best songsters. The goldfinch also aids us by eating the seeds of the thistle and dandelion; the meadow lark destroys grasshoppers, cutworms, etc., as does the song sparrow. The song sparrow also destroys many weed seeds in early spring and in the fall.

The vireo, robin, warblers, flycatchers and swallows destroy noxious insects. To this list of insect destroyers should be added the sparrow hawk for its destruction of grasshoppers; the nighthawk for its toll of mosquitoes, and the kingbird for its capture of flies.

Insects.—Insects are of value to us in Alberta for several reasons. (1) Many forms destroy noxious insects. Good examples are the dragonfly, ladybird beetles, ichneumon flies, tachina flies. (2) They carry pollen from one flower to another and thus bring about cross pollination. The bumble bees, and many butterflies and moths, some of the wasps and flies are the best examples of insect pollinators in Alberta. The honey bee, where found, performs the same service. (3) The honey bee provides man with a delicious food.

Snakes and Frogs.—The principal service of snakes has been mentioned already, namely, the destruction of mammal pests, such as mice, small gophers, and at times insects. The frogs and toads are useful to the extent to which they capture various noxious insects with their long tongue.

PLANT RELATIONSHIPS

1. **To Air.**—A simple experiment which will show that a gas (oxygen) is set free by the plant during sunlight may be performed easily. From the nearest slough obtain some water weeds which grow entirely below the surface of the water. Place them in an inverted position in a sealer of water, so that the cut stems of the plants are below the surface of the water. Then place the sealer in strong sunlight and have the children note progress from time to time. At first they will notice that small bubbles of gas form on the leaves. These bubbles gradually become larger and finally escape through the water into the air. They will notice that the gas passes off not only from the leaves, but also from the end of the cut stem. When the pupils have seen that a gas is set free in the sunlight, place the jar in a dark corner of the room anu have them note that the gas is given off more slowly. Finally cover the sealer with a dark cloth for about half an hour, and after uncovering have them see that the gas is no longer escaping. The sealer may then again be placed in strong sunlight in order to see that bubbles again start to form. The chief object of this experiment is for the pupils to see that a gas is set free. It may then be explained that the plant has the power during the day to take in the impure air, use some of the constituents in making starch and other foods, and then give out pure air. As a practical application house plants help to purify the air in the room during the day.

2. **To Light.**—To show the effect of light on plants, take two flower pots or tin cans, fill them with rich loam, and plant several sunflower seeds in each pot. Cover one pot with a box which will exclude all the light. Give the contents of the two pots the same amount of water, but be careful not to uncover the second pot for longer time than is necessary to add water, and have children make observations of the growth. The experiment should continue for about a month. The pupils will observe that the stems of the plants in the dark grow more rapidly than those in the sunlight. They will also see that the stems of the seedlings in the dark are thinner and weaker than those in the light. In fact, it will probably be necessary to put a small stake in the tin and tie the plants to it to provide support. The leaves of the plants grown in the dark will be much smaller and undeveloped than those in the light.

When the plants which have been grown in the light are about

4 or 5 weeks old have the children notice the position of the leaves about noon on a sunny day. Then cover the plant with a tight box for a day. Lift the box off and the pupils will observe that the leaves are drooping.

A simple experiment with some of the seedlings which have just developed the first pair of leaves is to place them in a sunny window with a box or sheet of brown paper behind them. In an hour or two the two cotyledons will be found bent towards the light. Even if we carefully cut off the cotyledons, the stems will turn toward the light.

If the sunflower plants in the garden are kept under observation before flowering it will be found that both stems and leaves are very sensitive to light. When the sun is shining brightly it will be noticed that the leaves at the end of the growing stem are rather drawn together in a rosette, which gradually turns so that it always faces the sun. The sunflower head turns for a time, but ceases to do so before the flowers come into blossom.

If the parents of any of the children are growing the oxalis as a house plant, they will notice that the leaves close at night. The bean and clover plants are also good illustrations of the same phenomenon. The sagebrush which is found growing throughout a large part of the province is a splendid instance of a plant which is protected from the strong sunlight by fine greyish white hairs.

TO MOISTURE.

Plants need water for several reasons: (1) Plants obtain a certain amount from the soil. These mineral substances can only enter the plant when they are dissolved in water. These solutions of plant food must be very weak in order that the plants can absorb them. Large quantities of water must, therefore, be taken up by the plant to obtain small quantities of food. (2) A certain amount of the water is used in the leaf to make starch, sugar and other substances. (3) The cells in the plant require considerable moisture to keep the plants firm. A good illustration of this third use of the water is the fact that we can restore wilted cut plants to a fresh condition by putting the stems in water for a time. A simple experiment will illustrate the process by which water with the mineral matter dissolved is taken into the roots. Hollow out the interior of a thick carrot so that the side walls are not more than ¼ inch thick. Obtain a cork that will fit snugly into the opening at the top. Fit a narrow glass tubing about 1 foot long into the cork. Fill the carrot with a solution of cane sugar of such a strength that crystals of the sugar will no longer dissolve in it at the room temperature. Add a few drops of dye to color the sugar solution. Insert the cork and tube in the carrot, mark the height of liquid in tube and set the carrot in a tumbler of water. Have the pupils examine the tube from time to time during the next two days to note the slow rise of liquid in it. This illustrates the passage of water through the walls of the root hairs. In our experiment, the water being less dense than the sugar solution, passed inward more rapidly than the sugar solution passed into the water. In the case of the living plant, the soil water is not as dense as the sap within the root hair and therefore the water passes into the plant. The term osmosis should not be used in this grade. It is sufficient for the pupils to see that the water can pass through the walls.

The fact that water travels up through the stem and into the leaves and flowers may be shown by cutting some shoots of sweet peas that bear white flowers and setting them in a bottle of red ink. Also place in the ink a few bleached celery leaves that have been freshly cut from a bunch. In a few hours or, at the most, in a day's time, the red color will begin to show in the white petals of the sweet pea and in the leaves of the celery.

The fact that the greater part of the moisture taken into the

plant through the roots passes out again through the leaves may be easily demonstrated. Take a small potted plant, which has been well watered, and cover the soil and pot with several layers of paper in order to prevent evaporation of water from them. Then invert a large glass sealer or pickle jar over the plant and set out of the sun. At first the pupils will be able to observe only a thin film of moisture forming on the glass. Then drops of water gradually form and trickle down the side of the jar.

TO CHANGES IN TEMPERATURE

The pupils need no proof that warmth is necessary for the growing plant. It is but necessary to draw their attention to the effect of a heavy frost on, for example, the potato plant, to show the necessity of a certain degree of warmth for the different parts of the plant to carry on their work.

Beans and cucumbers and tomatoes are good instances of tender plants to which even a slight frost proves fatal. The anemone and other early spring flowers can withstand much frost, while many of the trees display the ability to survive the severest winter.

There are many ways in which plants prepare for winter. The deciduous trees, such as the willow, balm of gilead, poplar and alder shed their leaves in the fall. This precaution prevents the undesirable features of leaves giving off more moisture during the cold weather than the roots can take in from the cold or frozen soil. Were this to happen for any length of time the plant would die for the same reason that smaller plants often wilt during a warm, dry period. These trees have made a provision for leaves, stems and flowers of the next year by the developing of winter buds (See Chapter V). They also store up food in roots and stems during the fall. Biennials, such as the large common thistle, store up food in the roots and underground stems in the autumn. This food not only keeps these parts of the plant alive during the winter but also provides food for the early start of the plant the following spring so that it may produce flowers and seeds during the second year.

THE GREAT PLANT FACTORY

The classical method of comparing the plant with a factory may be introduced in this grade. The green parts of the plant (the leaves and, in some instances, the stems) constitute the factory. The machinery consists of the cells containing the green coloring matter. The power which operates the machinery is the energy from the sunlight. The raw materials used are the water and dissolved minerals from the soil and the carbon dioxide from the air. The principal manufactured products are starch and sugar. The by-product is oxygen, which is given off into the air for use by plant and animal life. The working hours of the factory for the manufacture of the primary products are during sunlight. The method of transportation of some of the raw materials of the factory and of the finished products to the point where they are to be stored or used is by water. (Compare with ocean vessels). The warehouses in which the products are stored are the roots, stems, seed and, to some extent, the leaf itself.

Where the teacher has separated the starch from the potato, as indicated on page 38 of the Course of Studies, she may indicate to the pupils that this was the method by which the early settlers in Eastern Canada obtained starch for household use. She may also test milk for starch, and prove that foods of animal origin (meat, butter, eggs) used by man differ from plant products in not containing starch.

Chapter V.

GRADE VI.

MINIMUM REQUIREMENTS

The attention of teachers is drawn to the fact that section 3 under "Minimum Requirements" for this grade, as listed on page 48 of Part II of the Programme of Studies should read:

The adaptations in the body forms of different kinds of animals to their respective habitats and surroundings—three mammals, five birds, one fish and five insects.

On page 42 the first line in the second paragraph should read: Make a detailed study of **five** plants in bloom.

PREPARATION OF PUPILS' COLLECTIONS

In assisting the pupils in their choice of projects to be undertaken in this grade, the teacher should bear two points in mind—the encouraging of pupils to carry out a project in which they have a genuine interest, and the necessity of the pupils choosing different projects in order to have a variety of material for class discussion during the winter months. Thus a boy who is interested in insects should be encouraged to make a collection of insects rather than one of plants, in which he has little interest.

PLANT COLLECTIONS

Pupils who choose the collecting of 25 flowering plants as a project should start gathering material in the spring and continue collecting throughout the summer and early autumn. They will thus have a representative collection of the wild flowers of the district.

In April and May the anemone (crocus), violet, buffalo bean (golden pea), and buttercups are available. Later we have such plants as the cinquefoils, stinkweed, shepherd's purse, tumbling mustard, ball mustard, yarrow, bergamot, great willow herb (fireweed), wild geranium, harebell (bluebell), cow parsnip, blue bur (stickseed), vetches, giant hyssop, blue lettuce, northern bedstraw, meadowrue, and many other flowers. In the late summer and early fall the goldenrods, asters, sunflowers and thistles predominate. If the collecting of plants is postponed until school opens in September it is difficult to obtain good specimens of plants in bloom.

It is not necessary to have an elaborate plant press for drying the plants. Good results will be obtained by alternating plants and double thickness of newspaper and weighting down the material with an apple box containing 20 or 30 pounds of stones. The newspapers should be changed every second day as they lack the absorbent power of blotting paper. Usually plants should be left in the press for a week. The length of time depends upon the amount of humidity in the air and the quantity of sap in the plants.

In the mounting of plants which have an extensive root and underground stem system such as the goldenrods and thistles, a portion of the root a few inches long may be mounted side by side with a portion of the stem which shows the leaves and flowers. If the root is too thick, slices may be cut off the edges so as to reduce it to a flat form suitable for mounting. The most popular method of holding the specimens in place on the paper is by use of narrow strips of gummed paper. Some collectors make two small slits in the mounting paper through which they pass the strips, and fasten them at the back of the mount. The heavy plant mount paper of standard size (11½x16½ inches) is sold by the dealers in Calgary and Edmonton at 45 cents per dozen sheets. Plant mount paper of smaller dimensions (9¾x11 inches), which is used as refill for Chapman's Nature Study Portfolio, costs 25 cents for two packages. The common name of the plant, name of collector, and name of school district should be placed in India ink at lower right hand corner of each sheet.

INSECT COLLECTIONS

A pupil's insect collection should be representative of the forms of insect life found in the community. The following contents of a collection is purely suggestive:

1 cabbage or mustard white butterfly
2 species of "silverspot" butterflies
1 tortoise shell butterfly
1 sulphur (yellow) butterfly
1 mourning cloak butterfly, or
1 swallowtail butterfly
3 species moth
2 species ladybird beetle (lady bugs)
1 Colorado potato beetle (in south of province)
1 blister beetle (found on carragana and vetches in August and September)
1 diving beetle, usually brown in color
1 black ground beetle
2 species bumble bees
1 flying ant
1 "worker" ant
1 house fly
1 wasp
1 dragon fly
1 small grasshopper showing only slight development of wings
2 adult grasshoppers.

The above insects have been discussed previously in this book.

An insect net is an essential piece of equipment in collecting miscellaneous insects. The framework may be made from a piece of good quality fence wire. Bend the wire so that it forms the circumference of a circle 12 to 14 inches in diameter. Allow about three inches of wire at the ends, to be inserted into the hollow at the end of a broom handle. The net may be made of mosquito netting or good quality cheesecloth, and should be about 18 inches deep.

A poison jar may be prepared by taking a wide-mouthed pint sealer to your nearest druggist and having him place in it two or three small lumps (size of pea) of either potassium or sodium cyanide. Sufficient plaster of paris to cover the cyanide should then be placed in the sealer and a small quantity of water added to cause the plaster of paris to set. Immediately stopper the sealer, and set aside for two days. Then cut a piece of paper to fit snugly over the plaster of paris and prevent any of the white solid from falling out of the sealer when the latter is inverted. Bear in mind that the jar contains a deadly poison. The cover should never be left off the jar for any longer time than is necessary to place insects in it or to remove them. When this operation is being performed it is best to hold the jar as far as possible from the face in order that none of the poisonous gas may be inhaled. Butterflies, moths, bees, wasps, ants, flies and dragon flies usually die within a few minutes of the time that they are placed in the poison jar. Grasshoppers and beetles should be left in the jar for several hours.

Beetles and grasshoppers may also be killed by placing them in a small, wide mouthed bottle containing wood alcohol. If one does not have a poison jar available, moths and butterflies may be destroyed by pouring a few drops of kerosene or gasoline on the bodies (not on the wings) of the insects.

A simple stretching board for moths, butterflies, grasshoppers and dragonflies may be made easily. Two strips of wood about half an inch thick and 3 to 4 inches wide will serve as ends for the board. Take two strips of soft wood, 15 to 18 inches long, 3 to 4 inches wide, and about quarter inch thick. Nail one strip to the two ends, then nail the second strip so that it is a quarter inch from the

first strip at one end and half an inch from it at the other end. Tack a strip of soft wood, linoleum, burlap or cardboard on the under side of the two long strips of board so that it covers the space between the strips.

Black insect pins which will not rust may be purchased from supply firms at 50 cents per hundred. Fine needles will answer the purpose. Insects should be stretched within 24 hours of the time of killing, as the body and wings soon become brittle. In stretching insects, place an insect pin or needle through the thorax (the division of the body to which the wings and legs are attached). Pin it to the linoleum on the stretching board so that the body of the insect lies in the crevice between the two boards. Carefully draw one of the front or outer wings forward, place a narrow strip of paper across it, and pin the paper to the board (not through the wings of the insect), so that it holds the wing in place. The other wings may then be stretched in the same way. Insects should be left on the stretching board for two days.

It is unnecessary to place bees, wasps, ants, flies and beetles on a stretching board. In all common insects other than the beetles and true bugs the pin should be placed through the thorax. Beetles and bugs should be pinned through the right wing cover.

When pupils prepare a "working" collection of insects for study in the classroom during the winter, a cigar box or other soft wood box serves as the most suitable receptacle. A sheet of white paper bearing the names of the insects distributed on it may be pasted in the bottom of the box, and the insects mounted on pins or needles be then placed in their correct position. Another method is to put numbers cut from a calendar leaf in the bottom of the box. Then paste on the inside cover of the box a sheet of white paper bearing the names of the insects corresponding to the numbers. If the box is covered with art paper and passe partout binding used along the edge, its appearance is considerably improved. The advantage of this type of collection is that when it is necessary to examine the under side of the body of any insect, the pupil does not touch the specimen but simply holds it in proper position by the attached pin or needle. The box should be kept closed when not in use.

If the collection is made primarily for display purposes either in the school or at a school fair, a glass mount is most satisfactory. A sheet of window glass about 10 inches by 12 inches is a suitable size. A stiff sheet of cardboard should be cut the same dimensions as the glass. On this cardboard place a layer of sterilized absorbent cotton such as is sold by druggists in thin layers of various widths. Arrange the insects in vertical rows upon the absorbent cotton, keeping the butterflies in one row, moths in another, beetles in a third, etc. The glass may then be placed in position, and the whole mount bound together by a layer of passe partout binding along the edges. A second form of glass mount may be prepared by using a small picture frame instead of the passe partout binding. A shallow box with the insects placed on a layer of absorbent cotton and covered by a sheet of glass is another suitable type of mount.

COLLECTIONS OF WILD PLANT SEEDS

In supervising the collection of wild plant seeds by pupils, the teacher should insist upon the seeds being clean, dry and ripe. The following suggestions with regard to the seeds of specific plants may be of assistance in the work.

Lamb's Quarters (popularly but incorrectly pigweed). Seeds are ripe in September and October. Ripe seeds are shiny black in color, and flattened on one side. They are usually covered by a dull grey shell which may be especially removed by drying the seeds and rubbing them between the hands. The only other plant bearing seeds which may be confused with those of the lamb's quarters is the rather

rare redroot or true pigweed. The seeds of the redroot are oval in shape and flattened on both sides.

Stinkweed (French weed or pennycress). Seeds ripe May to October. Seeds are reddish-brown in color and are readily recognized by the looplike lines which run around the seed and terminate at the notch of the seed.

Tumbling Mustard. Seeds ripe August to October. Seeds are very small and vary in color from yellow to brown but always show a greenish tinge. Seeds are contained in long slender pods which are often confused with the stems of the plant. Before attempting to "shell" the seeds, the yellow mature plant should be thoroughly dried either in the sun or in an oven. If the pods are then held over a sheet of white paper and pulled apart, the seeds may be easily collected.

Wild Peppergrass. Seeds are ripe in July and August. They are reddish-yellow in color, and wider, flatter and slightly larger than the seeds of the tumbling mustard.

Shepherd's Purse. Seeds ripen during summer and early fall. They are light brown in color and likely to be mistaken for those of tumbling mustard. They lack the greenish tinge of the seed of the latter and are oblong.

Blue Bur (Sheep bur, stickseed, stickweed). The burs which develop when the small blue flowers go to seed are green in color at first. Later they turn greyish-brown. Each bur is composed of four pear-shaped seeds which are covered with hooked spines.

Canada Thistle (incorrectly called Canadian Thistle). The purple flower heads of this plant are from half an inch to one inch in diameter, and considerably smaller than the next species described. Seeds ripen from July to October and have attached to them light tufts of hair. Seed is light brown in color, about one-eighth of an inch long. In collecting the seeds of this plant the pupils will find that no seeds are found attached to the tufts of hair on the flower heads of many plants. The explanation is that some plants bear only male flowers, and the others only female flowers.

Common or Bull Thistle, Lance-leaved Thistle. The seeds of these conspicuous flowers of the late summer and autumn are much larger than the seeds of the Canada Thistle. They are a light yellow in color.

Prairie Rose. In order to prevent the seeds of this familiar flower from molding, they should be dried thoroughly in the sun, and any adhering pulp removed before placing in the vial.

Wild Buckwheat. This plant, which twines itself around the stalks of grain, is also found in many gardens. The seeds are usually ripe early in September. They are triangular in shape and dull black in color. Care should be taken that this black covering is not removed, exposing the white seed underneath.

Ball Mustard. The spherical seeds which form on the stem of this plant while yellow flowers are still in bloom higher up on the stem readily serve to distinguish the plant from the other mustards. The round seeds, which ripen from July to October, are pale yellow in color.

Blue Lettuce. The pale blue flowers of this plant are often confused with those of the smooth blue aster. The seed resembles that of the Canada Thistle in color and the white tuft of hair attached. It is longer than that of the thistle, and is striped with dents which are darker in color than the rest of the seed.

Wild Barley (Squirrel Tail Grass, Skunktail Grass, incorrectly called Foxtail). The seed ripens in July and August and has a barbed awn similar to that of the cultivated plant. The awns should be separated from the slender seeds.

Wild Sunflower. This name is applied to two wild flowers in

Russian pigweed

our province—the Giant Sunflower, which has a dark centre, and the Great Flowered Gaillardia, which has a reddish-brown centre. The dark colored seeds are ripe in August and September. They should be thoroughly dried for some time before placing in vials in order to remove the excess oil.

One-dram glass vials with aluminum screw tops are the most satisfactory containers for seeds. They are sold for 50 cents a dozen by local school supply firms. Small gummed labels bearing the names printed in India ink, may be placed on the vials. Twelve-ply white cardboard with one surface faced for taking ink makes a suitable mount for the vials. The standard size, 11x14 inches, is sent through the mail by supply houses. The vials may be attached to the cardboard by colored twine, a stout darning needle being used to draw the twine through the cardboard. Care should be taken to space the vials equal distance apart. A rectangular border in India ink about one-eight inch wide improves the appearance of the collection. The title "Wild Plant Seeds" may be neatly lettered either above or below the rows of vials.

COLLECTIONS OF LEAVES

The leaves should be dried and pressed in the same manner as that outlined for plants. If they are then dipped for an instant in melted paraffin they will retain their color. The leaves may be attached to a large sheet of art paper with paste, with the name of the plant from which it was obtained written neatly below each leaf.

DETAILED STUDY OF FIVE PLANTS

The following details for the study of five common plants may prove of value in the work outlined as a minimum requirement for Grade VI.

GOLDEN ROD

A species of golden rod which grows quite tall is most satisfactory for study. The best time to take up the work is at the opening of school in September. The soil should be loosened about the roots of the plant with a hoe or spade, and each pupil be provided with an entire plant.

Roots. The thick fleshy portions of the plant that run horizontally under the surface of the soil are not the roots of the plant. The roots are the numerous, thin, fibres, which spread in all directions. The term **fibrous** root and its meaning will be clearly understood when the pupils have examined the root system of the plant.

The three chief uses or functions of roots are also illustrated by the golden rod. If we try to pull one of the plants out of the ground we find that the roots hold it in place, and that many of them break off before the plant comes out of the ground. The use of the roots as an anchor for the plant is thus easily shown. The numerous fibrous roots of the golden rod, which spread out in all directions, are a much more effective anchor than a tap root would be.

The second use of the roots is to absorb water and the dissolved mineral matter from the soil. They act as tubes for the conveyance of the liquid. The numerous roots of the golden rod expose a large surface to the soil and enable the plant to use water from a greater area than would a single root.

The third use of the root as an organ for storage of food is not as clearly shown in the case of the golden rod as in the radish, beet and many other plants.

Stems. The golden rod has two kinds of stems. The tall, erect stem lifts many of the leaves of the plant above those of surrounding plants, and thus they receive more sunlight. It also carries raw materials to leaf and returns finished products to the roots and other parts of the plant. (See Plant Factory, Chapter IV). Around the

base of the upright stem are several white or pinkish shoots which run in all directions. These underground stems serve a double purpose. The food stored in them keeps the golden rod alive in winter when the erect stems have been killed off by the frost. In the spring a new plant grows from the end of each underground stem. This explains why the golden rod usually grows in patches and why we seldom find one growing alone. The underground stem, therefore, not only preserves the life of the plant over the winter, but is also a method of reproduction of the plant.

Leaves. If the pupils note carefully the arrangement of the leaves on the stem, they will observe that they form spirals and project outward and upward. This exposes a large leaf surface to the rays of the sun, since there is comparatively little shading. As the leaf is a plant factory (See Chapter IV) more food is made by the leaves when they are thus arranged, than if they shaded one another. If one examines the leaves around the base of the stem of the plant they are probably withered. One reason for their decay is that they have been shaded by the leaves higher up and have not been able to manufacture the different foods. The functions of the leaf in the matter of transpiration and respiration, as given in Chapter IV, may be reviewed at this point. The attention of the children should also be drawn to the small veins running through the leaf. These veins are really bundles of small tubes which conduct the sap to the different parts of the leaf.

Flower. The flower cluster of the golden rod, upon examination, will be found to consist of a number of small branchlets, each bearing a number of little yellow flower heads. Since the golden rod is a composite flower, each of these small flower heads is composed of a number of individual florets. The ray flowers along the edge of the head have bright yellow banners, while in the centre are a few disk flowers resembling bells. The grouping of the flower heads in a cluster no doubt attracts many more insects to the plant than if the flowers were scattered over the plant. The pupils will no doubt see the bumble bees which visit the flowers to obtain both pollen and nectar. The bees and other insects render a great service to the plant by carrying pollen from flower to flower on their bodies and thus bringing about cross pollination and production of seed. The butterflies and moths are attracted to the golden rod flower in order to obtain nectar, but in so doing are almost certain to carry away on their bodies some of the pollen dust.

Seeds. The seeds of the golden rod are very small. Each is provided with a tuft of fine hair, which enables it to be carried considerable distance by the wind. The large number of seeds produced by an individual plant provides for wide distribution of the golden rod.

Many other points may be considered in the discussion of the golden rod. The propagation by underground stems enables the plant to get off to a good start in the spring before the plants growing from seed can occupy the ground. Because of the straight stems and long, narrow leaves the plants can grow close together without shading one another to any great extent. The plant withstands the drought of our Alberta summers and the severe climate of our winters. The galls found on the stem of the golden rod were discussed in Chapter II.

TUMBLING MUSTARD

Root. Differs from that of the golden rod in being a **tap** root with several smaller rootlets extending from it. Pupils can tell by the comparative ease with which the plant may be pulled out of the ground that this type of root system does not provide as good anchorage as does the fibrous root system of the plant previously studied.

Stem. Main stem is 2 to 4 feet high when plant is mature.

Pupils should note that the many branches from the main stem give the plant a spherical shape. The change in color of the stem from green to yellow in the fall, and the difference in the brittleness of the green and mature stems should also be noted. They can thus readily see why the plant breaks off near the ground when mature, and is given the name of tumbling mustard.

Leaves. The first leaves that appear on the plant in the spring are pale green in color and covered with down. The leaves at this stage form a rosette like those of the dandelion and shepherd's purse. While the overlapping of the leaves in the rosette arrangement is not a very favorable one for obtaining sunlight, yet the pupils can see one adaptation for securing the most light possible under the circumstances, namely, that the lowest leaves of the rosettes are the longest. The upper leaves gradually become shorter so that all leaves have some of the surface exposed to the light. The rosette habit is usually regarded as an adaptation to prevent too rapid evaporation of moisture. The mature plant of the tumbling mustard has much finer leaves on the upper part of the plant than near the base. These smaller leaves, by exposing comparatively little surface to the action of the sun's rays, prevent too rapid evaporation of moisture from the leaves. They do not shade the lower leaves to any great extent.

Flowers. The small pale yellow flowers have the four petals in the form of a cross.

Seeds. The seeds are contained in long, slender pods, which are likely to be confused with the fine branches. It is a good exercise for the children to split one of the dry pods, count the number of seeds in it, and then estimate the number of seeds produced by a plant. Large plants often produce about a million seeds. Emphasis should be laid upon the great number of seeds, as it is the only method of reproduction of the plant. The seeds are scattered as the plant is blown from one point to another by the wind.

GIANT SUNFLOWER

Roots. If a plant of this showy wild flower of late summer is carefully dug up about the middle of September, one will find a great mass of roots. The smaller roots serve to anchor the plant and to obtain the water and dissolved mineral matter from the soil, while the thicker roots store up food for use the next spring.

Stems. Examine the thick roots and you will notice that there are thick creeping runners spreading out from among them. These underground stems, often called rootstocks, use the food stored up in the thick roots to promote their own growth in the spring. Leaf-bearing branches are sent out into the air from these stems, as well as roots into the underlying soil. As the rootstock continues to grow forward, the part near the parent plant gradually dies. The erect stem usually grows to a height of but two to three feet. Under very favorable conditions, it sometimes reaches a height of ten feet, hence the name giant sunflower. The erect stems and leaves are usually rough and hairy. The hairs are dead structures which reflect light and thus prevent too much light from reaching the working part of the plant. (See Chapter IV).

Leaves. The narrow, tapering leaves are arranged in such a position on the stem that they do not shade one another to any great extent.

Flowers. The flowers of this plant make a very interesting study for pupils of this grade. If any of the pupils have the cultivated sunflower growing at their homes, the flowers may be kept under observation during their development. The following points may be noted: (1) The banner flowers along the edge of the head do not produce seed, their chief function apparently being to attract insects to the disc flowers, which produce seed. (2) The disk flowers near the banner flowers develop first, and have gone to seed before the buds at the centre of the head have opened. (3) The different

stages in the flowering and seeding may be seen on a larger head. At the centre of the head, the flower buds are five-sided pyramids with a pointed chaffy bract at the bottom to protect the seed sac. In some instances the bud may still be covered by the green points of the bracts. Outside the buds we can see florets which have the corolla tube with its five lobes open surmounted by the dark brown anther tube. These are surrounded by rows of flowers where the anther tube is opening and the pollen being pushed out. Farther out are flowers in which the stigma with its two lobes protrudes from the anther tube, while near the banner flowers may be flowers from which the stigma and pollen have disappeared. These latter flowers are developing seed.

Seed. The seed of the sunflower differs from that of the dandelion thistle, and many other composite flowers in not having the hairy, fluffy attachment to assist the wind in carrying the seed from one point to another. The dark, oily seeds are a favorite food of many birds.

By observing the direction in which the heads of the sunflowers which are fully opened face in the morning and the evening, the pupils will realize that there is no truth in the idea that the flowers twist about so that they face the sun all day. One may note large masses of the flowers about sunset with practically none of the heads facing the west. The leaves and stem which are not full grown often change their position in order to face the sun throughout the day.

THE SWEET PEA

Roots. The most important feature about the roots of the sweet pea to which the pupils' attention should be drawn is the presence of little lumps or modules. The work of the bacteria in these nodules, in making the nitrogen of the air available for use by the plant should be mentioned.

Stems and Leaves. The long, slender stems, the alternate arrangement of leaves, and the work of the tendrils (really modified leaves) in helping the plant to climb, may be dealt with under this head.

Flowers. The sweet pea is a good flower for the study of the names and uses of the floral organs. The calyx may be thought of as the green blanket which protects the bud; the corolla, usually the showy, attractive part of the flower; the stamen, the part which produces pollen, and the pistil, the case which holds the seeds. The resemblance in shape of the flower of the sweet pea to a butterfly may be noted. Names may also be given to the petals. The large upper petal, often called the banner, is the most attractive petal. It protects the interior part of the flower before the bud opens. The two petals in front of the banner may be called the wings, while the two which are joined to form a hood are known as the keel, owing to the resemblance in shape to the keel of a boat. The two petals forming the keel should be carefully removed and the pupils note that the pistil is longer than are the ten stamens, and that some of the pollen has lodged on a hairy part of the pistil a short distance from the top. If they now examine a second flower they will probably see the end of the pistil protruding from the keel. The projecting keel is the natural landing place for a bee visiting the flower. The depression of the keel by the weight of the insect does two things. First, it causes the end of the pistil to strike the body of the insect; secondly, the hairy portion of the pistil near the tip strikes the insect a glancing blow and rubs some pollen on the insect. When the insect visits a second sweet pea the end of the pistil is likely to strike the pollen from the previous flower, bringing about cross-pollination. At the same time the insect obtains pollen to carry to the next flower.

Seeds. If a few of the earlier blooms on the plants are allowed to go to seed, the pupils may notice the drying and hardening of the flower. Finally the two parts of the pod curl suddenly and scatter

the seeds some distance. This method of seed dispersal is also seen in the case of the carragana and other plants.

PRAIRIE ANEMONE (Crocus, Pasque Flower)

This is the earliest of the spring flowers of the prairie, and is well known to the children under the name of the crocus.

Roots. The true roots consist of a number of fine fibres, the thick part growing underground being really a part of the stem.

Stem and Leaves. The portion of the stem above the ground is so short that the anemone is often spoken of as a stemless plant. The plant flowers before the leaves develop, but if the pupils examine the plants closely, they will see some leaves of the previous year's growth quite close to the ground. These leaves seem to spring from the roots and have many lobes.

Flowers. The flower is at the top of a long hairy projection springing from the roots, which many of the pupils will probably call the stem. The term, stem, must however be reserved for the part of the plant which bears the leaves. The children will probably want to apply the term, calyx, to the group of green bracts that form a cup below the flower. If these are pressed back they will find that a short stem separates them from the flower. Botanists have agreed that if the corolla and calyx are not both present on a plant, they will call the part that is present the calyx. Hence we must call the purplish part of the flower the calyx, although they correspond to petals of the corolla of other flowers. When the calyx is removed the pupils will find a great mass of yellowish-red stamens.

Seed. As the seed matures the stem-like projection above the green bracts rapidly lengthens. When the seeds are ripe in the early part of June this projection is often six inches long. The seeds have long, feathery tails, which enable them to be carried readily by the wind. The plant at this stage is often called the **Rag Baby** by the children.

MAMMAL STUDY

Under mammals are included the forms of animal life which are usually spoken of as animals by people in general. The choice of mammals to be studied will depend largely upon the district in which one is teaching. The following outlines on a few mammals are suggestive of the details to be discussed in this work.

THE BAT

We have several species of bats in Alberta. The little brown bat is one of the commonest forms. If a specimen is captured, it may be placed in a box covered with a piece of window screen. House flies and small pieces of raw meat may be supplied for food while it is under observation.

From the fact that they see the bat flying in the air about dusk children are likely to associate it more closely with birds than with mammals. It may be well at first to point out the striking differences between the bat and birds. One feature that will be noted immediately by the children is that the bat's body (not the wings) is covered with fur, resembling to some extent that of a mouse. The possession of sharp teeth is another important difference between bats and birds. The wings are the outstanding adaptation of the bat. They consist of an elastic membrane that is stretched between the four long toes of the front feet. It extends to the sides of the body across the upper part of the hind legs, and thence to the tail. These wings are so well adapted for movement through the air that swallows and possibly the humming birds are the only small birds which can compete in either speed or quick change of direction with the bat. Emphasis should be laid upon the value of the bat to man by its destruction of insects, particularly mosquitoes. These are captured on the wing in the same manner as is done by the swallows, namely, keeping the

mouth open during flight. The portion of the wing membrane extending between the hind legs and tail also assists in capturing insects in flight, as it is doubled up on the insects, which are then quickly devoured. The wing serves a third useful purpose. Not only is a bat not blind (despite the popular adage) but if its eyes are covered with wax and it is released in a room across which strings have been stretched, it will not strike one in flight. The fine hairs on the wings are supplied with nerves which are stimulated by the rebound of the air from any object which the bat is approaching. Hence the ability of the bat to dart at full speed in the dusk without striking any obstacle.

The fifth toe on the front feet is quite small and hooked, and extends from the front part of the wing. It is used to drag the bat along the ground at times. One of the reasons that the bat is unable to walk is that the knees bend backwards instead of forwards, as in the case of other mammals. The toes of the hing legs are all quite short and sharp, and enable the bat to hang head downward during the day.

The teeth are not used in procuring food but assist the animal in climbing. The young bats are sometimes carried by their mother on her flight in the evenings, hanging from her neck during their trip. In the fall, when the supply of insect food is no longer available, the bat seeks a sheltered spot such as a cave or barn, and hibernates until May or June.

THE WEASEL

The weasels show clearly the phenomenom known as protective coloration. During the summer months they are brown above and white or yellowish-white below. In winter the whole body except the black tip of the tail is white to match the snow. The two forms of the animal commonly found in Alberta are the long-tailed weasel, from 12 to 16 inches long, and the short-tailed weasel, a smaller animal which has a tail about two inches long. The latter animal and another form found in the far north, are trapped during the winter months and the fur put on the market under the name of American ermine. The black tip on the tail of the weasel, which persists throughout the year, is believed to be a mark by which other weasels will recognize it.

The canine teeth of the weasel are an adaptation not only for the destruction of other animals but also as a protective weapon when they are cornered. The long, narrow body enables it to pursue gophers, rats, mice and other burrowing animals into their dens. Its nightly raids on the poultry yards, where it destroys the fowl by either piercing the veins in the neck or under the wings, make it a serious menace in many districts. It is not content to kill only sufficient birds for its food, but seems to kill for the pure joy of killing. Some people have reported the destruction of 30 and 40 chickens in a night. Not only is it adapted for attacking animals on the ground but also is an expert tree climber, where it often destroys young birds. It is also an adept swimmer, and does not hesitate to pursue muskrat into the water. They have also been known to destroy one another.

The weasels seem to have keen sense of both smell and sight. Their homes are usually in burrows in the ground, but in some instances have been found in hollow logs. In a few instances there is evidence that they have stored up some food for winter. Instead of hibernating, they depend upon their winter coloration to help them approach their victims and escape their two chief enemies, the owls and man.

THE COYOTE

Although we commonly speak about the coyote as though it was one definite animal, investigation has shown that there are

several species in Alberta. From the standpoint of the pupils in Grade VI we may deal with coyotes in general, since coloration and habits of the different species are very similar. While the coyote is popularly regarded as the wolf of the prairie, it may be well to draw the pupils' attention that it is sometimes found in wooded country.

From observations made at different points in Western Canada it would seem that a pair of coyotes rarely travel more than 7 or 8 miles from their den. The den is usually dug on the sunny side of a bank. A deserted badger's den is often used. Close examination of the entrance to the den reveals an air hole leading into the den from above. In some cases this ventilator appears to have been originally the burrow of a gopher. The young coyotes are sometimes seen on an elevation near the mouth of the den, apparently on the lookout for the return of the parents with food. If a person discovers the den when young coyotes are quite small, and returns to the den a few days later, you are likely to find that in the meantime the parents have moved the young to another den. The family usually scatter in the fall, leaving only the two original occupants of the den.

From an economic standpoint the coyote works in the interests of man in the destruction of gophers, field mice and rabbits. Against this we must charge up against him the destruction of sheep, calves and antelope. Animals killed during the winter have been found to have eaten large quantities of rose hips and juniper berries. The long, lean body and legs of the coyote seem to adapt it not only for speed in pursuit of its victims, but also to escape from its enemies. In its pursuit of the rabbit and the antelope, which surpass it in quickness of movement, it displays considerable cunning. In the case of the rabbit it makes use of the fact that the animal runs in circles. One coyote will chase the rabbit for a time, then its mate will take up the pursuit, and in this way wear down the rabbit. Packs or four or five are sometimes found hunting the antelope. They work in relays, and by cutting across the arcs of the route which they believe will be followed by the antelope are able to spring upon the animal from a hiding place while it is pursued by other members of the pack.

Coyotes do not hibernate. During the winter when food is scarce they will often eat poisoned meat set out which they would not touch during the summer. The danger of the poison to dogs makes this an unsatisfactory method of destroying them. People who attempt to shoot the animal often note the almost uncanny cunning of the coyote in keeping outside of the range of the gun. The fur is not very durable, but it used at times in lap robes, driving gloves, etc. The trapping of the coyote is described in Chapter IV. The blending of the color of the coyote with the soil and yellow grass of its native haunts is often regarded as an instance of protective coloration.

BADGER.

The badger is a typical prairie mammal, and is rarely found in wooded territory. It prefers to live where plenty of gophers, ground squirrels, and field mice are available, and from the standpoint of its food habits is a valuable ally of man. The den in which the young are born is usually made in well drained soil about 2 or 3 feet below the surface. Many of the familiar "badger holes" are the work of the animal in its pursuit of burrowing animals.

The badger cannot depend upon its speed for escape from its enemies, as a man can easily overtake it. Its strong feet are especially well adapted for burrowing, and it can "dig itself in" very rapidly. When its front feet get a firm grip in the soil, it will defy a man of average strength to pull it out of a hole. Its thick, loose-fitting hide protects it from dogs, and its powerful jaws and sharp teeth are a formidable weapon of defense, leaving a deep

gash at practically every bite. During the cold season when it is difficult to procure food the badger adapts itself to its environment by promptly hibernating.

ADAPTATIONS OF FIVE BIRDS

Before dealing with the adaptations of specific birds it is well to take up the adaptations of birds in general for an aerial existence. If the wing of the domestic hen is used for study in the classroom the pupils can note that the quill feathers overlap; that the under side of the wing is concave. Hence when the wing is outstretched and moved downward the air is caught in a pocket under the wing. The resistance offered to the passage of air drives the bird upward and forward. On the upward stroke of the wing the convex upper surface of the wing offers little resistance, and the air passes freely through the feathers, thus impeding but slightly the forward movement of the bird. (We may compare the wing with an umbrella). The bird changes its direction either by using the tail feathers as a rudder or by moving one wing more rapidly than the other. The extension of air tubes into the bones of birds makes the bodies lighter; the shape of the skeleton with the keel at the front offers little resistance to the air; the temperature of the body is higher than that of mammals, and thus the body is lighter; the movement of the wings is controlled by very powerful muscles.

PRAIRIE CHICKEN.

The adaptations of the prairie chicken and the duck may best be studied during the open season for shooting of the birds, as freshly killed specimens are then available for study in the classroom. The chief adaptations to be drawn to the attention of the pupils are: (1) Coloring of the bird which blends with its surroundings during considerable time in year. (2) Horny covering on toes as protection. (3) Blunt claws for scratching the ground. (4) Short, strong, horny beak for shelling seeds, obtaining berries, etc. (5) Short, round wings which are capable of short, rapid flights only. (6) Large number of young birds in a brood prevent the extinction of the bird in many sections.

THE DUCK.

Any species of wild duck will show the following adaptations: (1) Webbed feet to act as paddles in swimming and to prevent the bird sinking in mud along the edge of the water. (2) Feet placed far back in body aid it in swimming, but make it ill adapted for walking (waddle). (3) Wide, soft, rounded beak enables it to procure considerable food from water at one time. (4) Tooth-like ridges or gutters on sides of beak which strain the water from the food. (5) Flavor of flesh descends largely upon food of duck. The merganser (sawbill) or fish duck of the mountains is useless for food, while the mallard after feasting on the grain fields has flesh of excellent quality.

THE FLICKER (YELLOW-HAMMER, GOLDEN-WINGED WOODPECKER)

(1) Bill is stout, straight, and chisel shaped, to enable it to drill into wood either to procure insects or to make the circular opening into its nest. (2) Tongue is sharp pointed and has many barbs to assist it in holding its insect prey. (3) Sticky saliva on tongue enables it to obtain ants easily from ant hill. Ants are the favorite food of flickers. (4) Stiff bristles in tail feathers act as prop for the bird when it is on tree or post. (5) Hooked claws or toes are well adapted for clinging to the rough bark of trees.

HAWK.

Any species of hawk will illustrate clearly the adaptations of birds of prey.

(1) Well developed toes with strong, sharp talons for capturing and holding its victims, and in some instances as a weapon of defense. (2) Hooked beak to tear flesh to pieces. (3) Keen eyesight, enabling them to see gophers, mice or other animals from great heights. (4) Long wings well adapted for strong flying and soaring for hours at a time. The explanation of the ability of the larger species of hawks to soar to great heights in a spiral with motionless wings is yet to be found. When the birds wish to descend, they draw the wings above back and drop rapidly.

SNIPE.

Either the lesser or great yellowleg snipe or the common jack snipe (also called English or Wilson's snipe) will serve to bring out the important features of shore birds. The curlew, sandpiper, willet or avocet are other representatives of the group.

(1) Long legs for wading in shallow water. Toes not adapted for perching. (2) Long neck and beak. The beak is not strong, but is used for probing in the mud. The beak has extremely sensitive nerves, which register the slightest movement of animal life in the mud. (3 The coloration is protective for the female bird at least during the nesting season. The nests are built among the grass near the water, and one will be at a loss to see the bird if she remains quiet.

GREBE.

There are many species in Alberta which vary considerably in size and color. The grebes and loons are our representatives of the true diving birds. The grebes are often popularly called the "hell divers." (1) Feet set very far back on body. This is a splendid adaptation for diving, but causes the bird to assume an upright position when they attempt to walk. (2) Nests built along water's edge, on islands or on floating mases of vegetation so that bird maye dive into water for protection. (3) Feet are either webbed (loon) or have lobes which are of great assistance in swimming. (4) Wings small in comparison with size of body. Differ from ducks in diving instead of taking to flight for protection. (5) Straight, narrow bills which enable the birds to get firm grasp on fish and other water life which is captured by diving.

PINE GROSBEAK.

The pine grosbeak, the common English or house sparrow, or the goldfinch may be chosen as representative for perching birds which are typical seed eaters.

(1) Short, strong beak which enables the bird to crush hard seeds. (2) Feet and legs are well adapted for perching, the feet being short and the hind toes as long as the middle toe.

SWALLOW.

The swallows or the night hawks (mosquito hawks) are good examples of birds which capture insects in flight.

(1) Beaks are small and extremely weak, since they are not used to any extent in procuring food. (2) Mouth very large. It is held open during flight, and forms a funner in which the insects are caught. (3) Wings very long and pointed ,enabling the birds to fly more rapidly than any other class of small birds. (4) Feet are very weak and not adapted for walking.

ADAPTATIONS OF FISH.

A goldfish, a small trout, pike or other fish caught by the pupils, or failing this a specimen from the store may be used in this work. (1) Spindle shape of body offers little resistance to water. (2) Tail fin is the chief organ of locomotion (compare with propellor of boat), movement being produced by rapid sidewise motion of the the tail. (3) The two pair of paired fins (one pair

just back of gills, and second pair on lower side of body) take the place of the legs of mammals, but are of little importance in giving speed to the fish's movement. When they are straightened out at right angles to the body they act as brakes, and also assist in balancing the fish. The other "unpaired" fins also act largely as balancers. (4) The overlapping scales protect the body of the fish, being smooth and causing little friction as the fish moves through the water. (5) The water which is taken in through the mouth passes out through two openings, one on each side of the neck. In these openings are the gills, made up of a number of fine threads, each containing a blood vessel. The blood gives off its carbon dioxide and takes in oxygen from the water through the walls of the fine threads. (6) The gill rakers (little rods projecting from the side of the gill arches) act as strainers, allowing the water to pass out through the gills slits, but guide the solid food down the throat.

ADAPTATIONS OF INSECTS

What is an insect? Before attempting to study the adaptations of insects it may be well to have the pupils compare their specimens of **adult** insects and learn the characteristic features. An adult insect displays the following essential features: (1) Six jointed legs. (2) Body divided into three main divisions—head, thorax, and abdomen. The thorax, the middle division of the body, has attached to it the legs and wings (if the latter are present). (3) The thorax and abdomen are divided into rings or segments. (4) One pair of feelers or antennate. (In some insects, such as the dragonfly, the feelers are not well developed). (5) Instead of a nose and lungs, insects have air tubes connected with breathing pores which lead to the surface. These show up quite distinctly on the abdomen of a large grasshopper as dots or depressions, one on each segment on each side of the body.

Two notable omissions have been made from the above list of characteristics. No mention is made of the possession of wings. While it is true that the vast majority of adult insects have wings, it is not an essential feature. Good examples of adult insects in our province which lack wings are the worker ants and the female of some generations of plant lice. The pupils will have no difficulty in obtaining specimens of both. A second omission is a striking feature of many insects, namely, compond eyes. Nearly all insects possess compond eyes, which reach a remarkable development in the case of the dragonfly. However, on certain small parasites which have little need of the ability to see, the compond eyes are absent.

If the pupils examine carefully the structure of a spider they can readily see why it is not classed as an insect. (See Chapter IV).

GRASSHOPPER.

The work on the grasshopper may best be treated early in September, when large specimens are available. The following adaptations may be brought out from the study of dead specimens and observation of live specimens, either in the field or in a large sealer:

(1) The hind legs are exceptionally well adapted for jumping. Note the strength and width of the division of the leg adjoining the small joint next the body (femur). Also note that this division is nearly as long as the body of the insect. The next division of the leg (tibia) is very stiff. By watching a live specimen the pupils can see the insect lower the femur until it is parallel with the tibia, and then straighten the two divisious out quickly, thus sending the grasshopper up into the air. (2) "Singing" of some male grasshoppers while not in flight is produced by rubbing the rough inside of the jumping legs against the upper surface of the outside pair

of wings. (Note the teeth-like projections on the tibia of the jumping legs). Others produce sound by placing the femur and tibia of the jumping legs close together, lifting the jumping lefs off the ground and moving the legs up and down rapidly. The sound made while in flight is often produced by rubbing the under surface of the base of the upper wing over the upper surface of the base of the lower wing. (3) The wide under wings are well adapted for flight. The thick, tough upper wings act as a protection for the lower wings, and are of little value in flight. The grasshopper is in flight only a small part of the time, hence the function of the upper wings in protecting the flying wings from mutilation. The drab color of the upper wings is also in the nature of protection for the insect while at rest. Note the red, yellow or other conspicious colors of the under wings in contrast with the color of the upper wings. The manner in which the wings are folded also renders the insect less conspicous than it would otherwise be. (4) Emission of dark, ill-spelling liquid from mouth ("spitting tobacco juice") when seized is probably a means of defense. (5) Use of four pointed projections on the tip of the abdomen of the female as a tool in digging a hole in the ground into which the eggs are placed. (6) The two powerful jaws for cutting grass. These jaws work from side to side instead of up and down as ours do. (7) The "young grasshoppers" as they develop molt their skins when the latter become so hard that they interfere with the growth of the insects. Specimens showing the grasshopper in different stages of development from the very small ones with no wings, to the full grown adult may be obtained easily.

DRAGONFLY

(1) Huge compound eyes enable them to see in all directions. (2) Long powerful wings constantly outspread carrying them rapidly through the air (compare with "wings" of an aeroplane). (3) Long slender abdomen serves as rudder in flight, enabling the insect to change its course with lightning rapidity. (4) Strong front legs and great jaws for grasping their victims (mosquitoes, other dragonflies, etc.). Do no damage to human beings despite the name darning needle which is often applied to them. (5) In the nypmh (young dragonfly), which lives in sloughs and still water, water is drawn into a cavity in the abdomen where the air dissolved in the water is used in a similar manner to that employed by the gills in a fish. The expulsion of the water from this cavity drives the nymph ahead, thus assisting the legs in swimming. (6) The lower lip of the nymph is very large, and is usually folded back under the body. It can be suddenly thrust out to capture insects. Thus the nymph does not need to depend upon its speed to procure its prey.

MOTHS AND BUTTERFLIES.

The adaptations of these insects in each of the four stages may be taken up. For identification of common moths and butterflies, see Chapter II, and for the life histories refer also to Chapter II.

The eggs of moths and butterflies are usually laid on the plants upon which caterpillars will depend for food. For example, the monarch butterfly always lays its eggs upon the milkweed plant; one form of hawk (sphinx) moth invariably lays its eggs upon the northern bedstraw; the cabbage white butterfly lays the eggs on cabbage, cauliflower and similar plants; clothes moths lay the eggs upon textiles. In the case of many cutworm moths the eggs are often laid on grass or weeds in late summer or fall, upon which the caterpillars feed until the cold weather. In the spring they destroy grass for a time, but when opportunity presents itself turn their attention to cultivated plants.

The caterpillar stage is the period of growth for the moth and butterfly. A small moth does not become a large moth, neither does a small butterfly develop into a large butterfly. To enable

it to devour leaves and other food, the caterpillar has biting mouth parts, which may easily be seen in action if a caterpillar with some leaves of the plant upon which it was found are kept in a glass jar. As the small caterpillar grows its skin becomes quite hard. In order to prevent interference with its growth, the caterpillar sheds or molts the hard skin. The skin underneath is soft, and prevents growth for a time. When this second skin hardens, it in turn is shed. The number of times the caterpillar sheds its skin before reaching full size varies to considerable extent. A third adaptation possessed by caterpillars is related to its method of movement. Each of the first three segments back of the head bears a pair of jointed legs. These three segments become the three segments of the thorax of the adult moth or butterfly. In addition to these "true legs," the caterpillar has several pair of soft, fleshy legs on segments farther back on the body. These "pro legs," as they are called, aid the caterpillar in crawling, but are found on either the pupa or the adult.

The pupa stage of moths and butterflies is a period when they are unable to defend themselves. Various protective adaptations are found in this stage. The best known protection is the spinning of a cocoon by the caterpillars of many moths, e.g., forest tent caterpillar, tussock moth, cecropia moth. The caterpillars of other species of moths spin no cocoons, but spend the pupa stage in the ground, where they are not exposed to many enemies. The cutworm and hawk (sphinx) moths are good examples of this type of protection. Caterpillars of butterflies do not spin cocoons. The chief protection seems to be that the pupae are generally of an inconspicuous color. The conspicuous black and red of the caterpillar of the mourning cloak butterfly is replaced by a grey pupa which resembles a dead stem of the willow tree, upon which it hangs. Many other instances of the inconspicuous coloration of the pupae of butterflies can easily be found.

Moths and butterflies in the adult stage all show clearly the adaptation of very fine scales on the wings. These scales shed water, give strength to the wing, and also determine the color of the different parts of the wing. The adult moths and butterflies cannot do any damage, as they lack biting mouth parts. They have instead a coiled sucking tube which can be extended to extract nectar from flowers. This tube shows up very distinctly in the larger butterflies.

BUMBLE BEES.

(1) Children often state that they see only large bumble bees early in the spring, while later in the season the insects are of various sizes. As far as is known, the queen bumble bees are the only ones which live over the winter. They differ in this respect from the honey bees. Needless to say, no honey is stored up for winter use. The burrow of a gopher or field mouse is often used as a place of refuge during the winter months. (2) Queen bee in spring gathers nectar and pollen and forms small masses of "bee bread," a mixture of honey and pollen. Eggs are laid upon this mass, the young larvae live upon the bee bread, form cocoons for pupa stage, and emerge as worker bees about half the size of the queen. These worker bees do all the later work of gathering pollen and nectar, care for the later broods, and strengthen the pupa cases with wax in order that honey may be placed in them for use of the bees. (3) Bumble bees show two adaptations for carrying pollen—the "fur" on the body and widening of one dicision of the hind leg to serve as a pollen basket. (4) They have very long tongues, which enable them to obtain nectar from the bottom of narrow flowers. If the pupils watch the bees at work on the flowers they can see the tongue in action.

WASPS.

There are many species of wasps. The one best known to the children is one of the "hornets" which build paper nests. Interesting features concerning these are: (1) Only queens live over the winter. (2) Early in spring queen chews bits of old wood and makes wasp paper, which she uses in building a small nest. This nest has only a few cells inclosed in a covering with opening at lower end. (3) Eggs laid in each cell and chewed insects provided as food for the worker grubs, which will later emerge. These worker wasps (smaller than the queen) enlarge the nest, adding more combs and cells, and provide chewed food for the young. (4) Cells are used for homes of wasps, and one can tell (by size of nest) the number of occupants. (5) The paper pulp is laid on in little layers, which can be easily seen if a deserted nest is examined. The enlarging of the nest is carried out by cutting the paper on the inside of the covering. thus giving room to widen the comb. Extra layers are then built on the outside of the nest. (6) Sting of wasp, which is situated near the end of the abdomen, is not left in a person's flesh as is that of a bee. Hence a wasp may sting several times.

SOIL

HOW SOIL IS MADE.

The pupils should be led to see that soil consists largely of rock that has been ground up by many agencies in nature. If a river bank or cut bank is situated near the school, the children can see several of these agencies at work. They can see running water striking pebbles against one another, and against the river bottom, thus grinding up some of the rock. At another point they can see how the water is wearing away some of the sandstone or shale rock. The work of frost in breaking up rock is evident in many districts. To show the effect of rapid changes of temperature upon a rock, heat a pebble to a high temperature on the stove, then drop it into cold water, and see if any cracks are formed. The effect of the wind in carrying sand and small particles of rock and blowing them against other rock, thus breaking them up, may also be mentioned. The action of the air in causing the disintegration of rocks may be compared to the rusting of iron when left exposed to the weather. In some districts the children may be able to see trees or even smaller plants obtaining a foothold in a crack in a rock, and gradually breaking it up. In shady, damp places they may also be able to see the work of mosses on stone. The decay of plants and of some forms of animal life (insects, gophers, etc.), which add their quota to the soil, may also be seen in any district.

CONSTITUENTS OF SOIL.

If a small quantity of rich garden soil is thoroughly dried, it may be easily divided into the three principal constituents. Pulverize the dry soil and place it on the cover of a tin can, and heat strongly either on the top of the stove or over a strong alcohol flame. The pupils will note the smoke and odor given off, and the change in the color of the soil. We have thus driven off the humus (vegetable matter) from the soil. When all the humus has been discharged, allow the soil to cool. Place about a tablespoonful of the cool soil in a tall glass tumbler or sealer about two-thirds full of water. Shake the container vigorously up and down for a minute, then hold a sheet of white paper behind the glass vessel, and have the pupils note the settling of the sediment. This consists largely of sand. The muddy water contains the clay. The muddy water may be poured off into a basin and the sediment at the bottom of sealer again shaken up with water, allowed to stand, and water again poured off. If this is continued until the water is quite clear after allowing the sediment to settle for a period of one

minute, a good sample of sand may be obtained. If the muddy water is allowed to stand for several days, the clay will gradually settle out. The pupils can note the fine texture of the clay as compared with the sand. Their attention may be also drawn to the sticky nature of wet clay, as is clearly shown on their shoes after walking through a clay soil in wet weather.

REASONS FOR CULTIVATING THE SOIL

Among the principal reasons for cultivating the soil are: (1) To enable the air to penetrate more deeply and thus give the roots of plants a better opportunity of growing. Note how when soil becomes tightly packed around a house plant, the plant does not grow quickly. Also the response to frequent cultivation. (2) To drain off excess moisture, thus warning the soil and promoting more rapid growth. Have the pupils note the difference in temperature between a moist soil and a dry one. (3) To prevent evaporation of water by forming a mulch. This is of particular importance in dry farming practice. Reference may be made in this connection to the cultivating of the summerfallow. (4) To give the soil a finer texture and thus enable the water to be brought more readily to the upper layer of soil for use by the plant.

AIR

REALITY OF AIR

A simple experiment to show that air takes up space and is "real" may be performed for the class. Place the stem of a funnel through a hole in a cork which will fit tightly in a bottle or sealer. Have one of the pupils try to pour water through the funnel into the bottle. It is impossible to do so because the so-called "empty" bottle is really full of air. Now place a second hole in the cork and repeat the experiment. The water now passes freely into the bottle because it is able to drive the air out of the bottle through the second opening.

WEIGHT OF AIR

In showing that air has weight the inner tube of an automobile tire may be used. It should be carefully weighed so that the pupils can see that the scales just "balance." The tire may then be inflated with a bicycle pump and the children note that the "balance" is disturbed. The bladder of a football or a basketball may be used instead of the automobile tube. The weight of a cubic foot of air may be taken approximately as 1¼ ounces. Have the pupils calculate the weight of the air in the classroom.

PRESSURE OF AIR

Two simple experiments will illustrate this point. Have a pupil try to suck water out of a full bottle through a glass or metal tube which fits snugly in the opening in the cork. Then place a second hole in the cork and note the difference. In the second instance the water is really pushed up the tube by the weight of the air entering the bottle through the second opening. The pupils should understand that in applying suction to the tube their comrade removed some of the air and therefore some of the pressure above the water in the tube.

Fill a tumbler with water and place a sheet of water on the top of it. Hold the paper tightly with the palm of the hand and invert the tumbler. The water does not come out of the tumbler because the pressure of the air keeps it in. (The upward pressure of the air is greater than the downward pressure of the water).

CARBONIC ACID GAS IN THE AIR

Experiments should be carried out which will show the test for the gas, the sources, and common uses. Prepare some lime water by

placing a teaspoonful of lime in a sealer of water. Place the cover on the sealer, shake the contents thoroughly and allow to stand for three or four days. Have one of the pupils blow his breath through a straw into a small quantity of clear lime water and note the result. The milkiness imparted to the lime water may be taken as the test for this constituent of the air. The experiment illustrates one of the chief sources of the gas, namely, the respiration of animals.

Place a large sealer tightly over a growing plant which has abundance of leaves and set in the dark for a day. Then test with lime water and show a second source—the respiration of plants. The plant was kept in the dark in order that the leaves might not carry on the starch-making process and use up the carbon dioxide set free by the plant in the breathing process.

Invert a dry sealer over a lighted candle or splinter, and have the pupils note that the flame is eventually extinguished, showing one outstanding property of carbon diovide. Cover the sealer and set aside for a minute to cool, then pour a little lime water into sealer, shake and note milkiness imparted to the lime water. This shows the third important source——the combustion of fuels.

The most important use of carbon dioxide is by the plant in the manufacture of starch. Other common uses may be shown by experiment. Remove the cork from a bottle of soda water, ginger ale or other soft drink, shake the bottle thoroughly and hold a tumbler containing a little lime water below the mouth of the bottle for about two minutes. Cover the tumbler, shake, and note change in lime water. This illustrates the use of carbon dioxide in "carbonated" drinks.

Place a tablespoonful of baking powder in a small bottle, and in a second narrow-necked bottle place about an inch of lime water. Add a little warm water to the baking powder and hold the mouth of the bottle containing the lime water immediately below the mouth of the first bottle. When action has ceased, shake contents of second bottle and note results. Repeat the experiment, substituting baking or washing soda and cold, strong vinegar for the baking powder and warm water. This shows the presence of carbon dioxide as the active gas in leavening agents, causing biscuits to rise. The last experiment also shows a common method of setting free carbon dioxide in fire engines and liquid fire extinguishers. Sulphuric acid and washing soda solution are the materials ordinarily used in many of these extinguishers. The inverting of the extinguishers brings the sulphuric acid into contact with the washing soda solution, and carbon dioxide is set free so rapidly that it drives the solution with it out of the tube of the exinguisher. The carbon dioxide smothers the flame.

HEAT

The sun should be emphasized as the great source of all heat. The various fuels (coal, wood, gas, oil, etc.), owe their formation to the energy of the sun's rays and simply give out stored energy to us in the form of heat. Needless to say, the idea of the term, energy, as here used is not within the grasp of Grade VI pupils.

In order to show the production of heat by rubbing substances together (friction), have the pupils rub their hands briskly and note the change in temperature of the hands. Other simple experiments can also be used, such as sawing a string across the edge of a board, rubbing a button on cloth, or boring a hole in hardwood and feeling the bit. Many applications of this idea may be mentioned. Savages in some parts of the world still obtain fire by rubbing two pieces of wood together until they are hot enough to light some dry cinders. The striking of a match to raise the temperature sufficiently to ignite the chemicals on the tip of the match is another application. The forming of "hot boxes" on the bearings of railway coaches is also due to friction, as is the heating of an axle of a wagon. This last point enables us to introduce the idea of lubricants (oils and grease)

on cars and machinery in order to lessen friction and therefore prevent heating of the metals to too high a temperature.

If a nail is hammered flat on a piece of iron or flat stone and the increase in temperature noted, the pupils will observe another method of producing heat. They may also strike sparks from stone. Reference may then be made to the use of flint and steel for producing fire by white people until the invention of matches about 100 years ago. The idea of percussion in the modern rifle and shotgun is another application. In dealing with the production by living bodies, particularly animal life, we may consider our bodies as furnaces, the waste cells of our bodies combining with the oxygen of the air supplied by the lungs and producing heat. When a pupil works hard at manual labor or runs fast, he becomes warm because he breaks down more cells, or we may say, provides more fuel for the fire.

Reference should also be made to the production of heat by electricity and its application to electric stoves, lights, toasters, etc. If a battery from a car is brought to the school a fine strand of picture wire may be attached to one of the insulated wires leading from the battery. If the circuit is then completed by touching the end of the other insulated wire to the tip of the picture wire, sufficient heat will be set free to melt the strand of wire.

EFFECT OF HEAT ON GASES, LIQUIDS, SOLIDS

To illustrate the effect of heat on air, obtain a tall narrow-necked bottle, for example, a vinegar bottle. Invert it over a tumbler of water so that the neck of the bottle is only about half an inch under the surface of the water. Wrap a cloth soaked in boiling water around the lower part of the bottle and have the pupils note that air bubbles soon rise through the water owing to the expansion of the air by heat.

To illustrate expansion of liquids, fit a glass tube or soda straw through the cork stopper of the bottle. Fill the bottle with water that has been colored with ink or dye, insert the stopper and make an ink mark on the tube to represent the height of the liquid in the tube. Place the bottle in a basin of warm water and have the pupils note the rise of the liquid in the tube. Then transfer the bottle to a vessel of cold water and have them observe the gradual fall of the liquid in the tube. The application of the expansion of liquids to the thermometer may then be shown. In registering temperatures out of doors in Alberta, the thermometer used usually contains alcohol colored with a dye.

To demonstrate the expansion of solids by heat, take an iron bolt or rod at least eight inches long. Drive two nails in a piece of wood so that the iron when placed lengthwise will just pass between them. Heat the rod in the stove, grasp it with a monkey wrench, and endeavor to place it between the nails. The increase in length of the rod will be evident to the children. If the bolt has a large square head, the experiment may be varied by adjusting the monkey wrench so that it just grasps the head of the bolt. Then heat the bolt and show that the head will no longer fit between the jaws of the wrench.

A variation of the ball and ring experiment of physics may also be used. Make a ring on the end of a piece of copper wire (electrical wire with insulating material removed will answer the purpose), of such a size that it will almost let a marble drop through it. Then hold the marble in the ring over an alcohol flame or hot coals. The pupils will see that the marble soon falls through because the heat has expanded the metal in the ring. As applications of the idea of expansion, the loosening of the metal rim of a sealer in warm water may be quoted. We may also have the pupils notice that in laying the rails on a railway track provision is made for expansion by the heat of the sun by leaving a small space between the ends of the rails.

RELATION OF HEAT TO PLANT AND ANIMAL LIFE

The importance of heat to plant and animal life is clearly understood by pupils of this grade. Good examples of different ways in which protection is afforded the plant during the winter are available in every district. The large, common thistle stores up food in the roots during the first season of its growth, the root is protected by the soil from the frost during the winter, and the plant bears flowers and seeds during the second year. The golden rod, as we have already seen, survives by sending out underground stems in the fall. Many trees shed their leaves in the fall so that the plant will not give off moisture during the cold weather. Food is stored up in the sapwood of limbs, branches and trunks of the tree during the winter to be used by the leaves in the spring.

If twigs of the balm of gilead or of any other tree that has large buds are brought into the classroom during the winter, the pupils may see clearly the adaptations for protection. Cut one of the buds in two lengthwise and note the tiny leaves. Also note that the buds are protected by firm, dry scales, covered with wooly hairs that protect the bud from loss of water during the cold weather. If the bud of a balsam poplar is available, the pupils can see the way in which it is protected by a layer of varnish. These winter buds give rise later not only to leaves but also to branches. The familiar bud of the willow contains flowers instead of leaves, as may be shown by keeping some twigs in water in February or March and noting the development of the pussies. If a twig of the saskatoon or cherry is developed in water, the pupils will see that the bud contains both leaves and flowers. In the case of the "evergreen" trees such as spruce or pine, the pupils' attention may be drawn to the fine needle-shaped leaves to which the "dry" snow will not adhere, the tough elastic branches which sway with the wind and the resin or varnish in the leaves and stems which protect the tree against frost and rain.

The study of the preparation of animals for winter in this grade will consist largely of a review of features taken up in the earlier grades. Under this head would come hibernation (gopher, bat, frogs, toads), storing of food in winter homes (beaver, chipmunk, some mice); building winter homes near food (muskrat); putting on warmer clothing (rabbit, ruffed grouse, cow); forming of cocoons by caterpillars of some moths(cecropia, tussock); passing pupa stage in ground during winter (cutworms often do so).

In dealing with the changes man must make in order to live successfully in climate of extremes of heat and cold, we may mention the providing of warm houses for the severe winters, the growing of sufficient food during the summer to provide for the winter, the necessity for warm clothing for the winter, the storing up of fuel, furnishing shelter for live stock, eating food during the winter which will provide plenty of heat for the body, etc.

WATER

The place of water in the life of the plant is dealt with in the work on Plant Relationships in Chapter IV. In addition to the uses man makes of water, mentioned on page 43 of the Course of Study, stress should be laid upon the influence on climate of large bodies of water. (Compare Alberta and the coast of British Columbia). This may be correlated with the geography of the same grade by reference to the famous fruit growing region of the "Lakes Peninsula" in Ontario. In the same way, the children may find out the source of the power for production of electricity in use in the nearest town. They will discover that the power plant uses coal to produce the steam to drive the dynamos. This may then be compared with the method of developing the power at Banff, Calgary, Exshaw, etc., where the electricity is generated at waterfalls and dams, and brought to these towns.

Rain water or water obtained by melting snow may be treated with a small quantity of soap and the children note that a lather is easily produced. The significance of the term, "soft water," is thus seen. Now test some river water in the same way and note that it requires more soap to produce a good lather and that a curd forms on the surface of the water. This is said to be a "hard" water. The question is immediately raised as to what has made the water hard. This may be answered by some simple experiments. Evaporate some rain water and have children note that there is no residue. Do the same with some hard water and note the difference. (The scale at the bottom of the tea kettle is the mineral matter which was dissolved in the water). Add a little soap to some lime water and note that the same effect is produced as in the case of hard water. These experiments bring out the fact that the hardness in water is due to the minerals dissolved in it. In Alberta the hardness is largely due to limestone rock. If a few drops of hydrochloric acid are placed on the scale from the tea kettle, there will be considerable effervescence owing to the carbon dioxide set free from the limestone.

NATURE MAGAZINE, published monthly by the American Nature Association, 1214 Sixteenth Street N. W., Washington, D. C. is the best magazine now available for nature students. It contains excellent illustrations and, in addition to popular articles about nature, has a Nature Study School Department edited by Mrs. A. B. Comstock. The annual membership fee of the American Nature Association, 3.00, covers not only the subscription to Nature Magazine, but also entitles the members to bulletins which are issued from time to time.

ILLUSTRATED CANADIAN FOREST AND OUTDOORS, published by Canadian Forestry Association, Ottawa (20 cents per copy, $2.00 per year), has excellent illustrated articles every month.

BIRDS OF EASTERN CANADA, by P. A. Taverner, is of particular value in studying the identification and economic status of Canadian birds. It contains 100 colored illustrations. Despite its name, the book deals largely with birds which are native to Alberta. This is a government publication which may be obtained at a cost of 50 cents upon application to the Director of the Victoria Memorial Museum, Ottawa. A new publication, BIRDS OF WESTERN CANADA, will be available from the same source early in 1926.

BIRD LEAFLETS. Teachers who purchase copies of the various books on birds complain that these books do not give sufficient detail on common birds. The National Association of Audobon Societies, 1974 Broadway, New York City, the leading organization for the study of birds in North America, has solved the teachers' problem by issuing educational leaflets on birds. The leaflets are 5½x8½ inches, and contain four pages of descriptive text, a separate colored plate of the bird, and an outline on drawing paper, intended to be colored by pupil or teacher. These leaflets are sold by the association at 5 cents each, provided that no order is less than 25 cents. Leaflets of the following Alberta birds are available: Nighthawk, flicker, marsh hawk, red-shouldered hawk, sparrow hawk, purple martin, goldfinch, kingfisher, blue jay, killdeer, bluebird, red-winged blackbird, snow bunting, song sparrow, barn swallow, tree swallow, mallard duck, sharp-shinned hawk, house wren, Franklin's gull, robin, cedar waxwing, least and semi-palmated sandpipers, horned lark, ruby-throated humming bird, willow ptarmigan, chickadee, ruffed grouse, catbird, pintail, crow, loon, kingbird, shoveller duck, avocet, English sparrow, white-throated sparrow, phoebe, pileated woodpecker, slate-colored junco, least bittern, red-eyed vireo, yellow-bellied sapsucker, bronze and purple grackle, great horned owl, Canada goose, green-winged teal duck, western meadowlark.

The National Association of Audobon Societies also issues pocket bird collections. These are educational folders, 5x8 inches, printed on light card for pocket reference. Each folder shows a group of birds, drawn to uniform scale and in full colors. They are valuable for classroom study and for identification in field work. These "collections" cost 10 cents each. The one of greatest value to Alberta teachers is entitled "Permanent Resident and Winter Visitant Land Birds of the North-eastern States," showing 63 birds which, with few exceptions, are found in our province.

This association also published three pamphlets which are useful to teachers. "Attracting Birds About the Home" has illustrated articles containing designs for bird houses, bird tables, etc. The cost is 15 cents. "Bird Study in Elementary Schools," 25 cents; and "Primer of Bird Study," 18 cents, are the titles of the other pamphlets.

The Perry Pictures Company, Malden, Mass., publishes colored bird pictures which, when mounted on stiff cardboard, are valuable for classroom use. The large school supply firms, such as F. E. Osborne, Calgary, and E. N. Moyer Co. Ltd., Edmonton, carry in stock the Perry colored bird and animal pictures, which are sold at 5 cents each. The catalogue of the Perry Pictures Company, which may be obtained for 15 cents by writing directly to the company, is useful to every teacher, as it gives not only the price list of all prints made by the company, but also shows small reproductions of several hundred pictures.

NATIVE TREES OF CANADA gives full descriptions of 100 trees native to Canada. It has excellent illustrations not only of the trees but also of the leaves, twigs and fruit of the common species, as well as maps showing the distribution of each species. This government publication may be obtained from the Director of Forestry, Department of Interior, Ottawa, for the sum of 50 cents.

The following bulletins may be obtained free of charge upon application to the Publications Branch, Department of Agriculture, Ottawa:

Common Garden Insects and Their Control.
Control of Cutworms in Prairie Provinces.
Insects Attacking Trees in Prairie Provinces.
Weeds and Weed Seeds.

Large colored posters of several noxious weeds of Alberta may be obtained free of charge by writing to Mr. W. J. Stephens, Field Crops Commissioner, Legislative Buildings, Edmonton. In your letter state that you are a teacher and give the number of your school district.

Clarence A. Weekes

Lawrence A. Weekes

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